

# Subnational tailoring of malaria strategies and interventions

Reference manual





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# Abbreviations

ACER	average cost-effectiveness ratio
ACT	artemisinin-based combination therapy
ANC	antenatal care
AQ	amodiaquine
ARIMA	autoregressive integrated moving average
CEA	cost-effectiveness analysis
CET	cost-effectiveness threshold
CHAI	Clinton Health Access Initiative
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station
CHW	community health worker
CM	case management
DALY	disability-adjusted life year
DHS	Demographic and Health Surveys
DOT	directly observed therapy
EE	economic evaluation
EIR	entomological inoculation rates
EPI	Essential Programme on Immunization
G6PD	glucose-6-phosphate dehydrogenase
GCEA	generalized cost-effectiveness analysis
GDP	gross domestic product
GED	gender, equality and diversity
GIS	geographic information system
HFCA	health facility catchment area
HMIS	health management information systems
ICER	incremental cost-effectiveness ratio
IEC	information, education, communication
IMHE	Institute for Health Metrics and Evaluation
IPTp	intermittent preventive treatment in pregnancy
IPTsc	intermittent preventive treatment in school-aged children
IRS	indoor residual spraying
ITN	insecticide-treated net
iCCM	integrated community case management
LGA	local government area
LSM	larval source management
MDA	mass drug administration

MIS	Malaria Indicator Survey
MODIS	Moderate Resolution Imaging Spectroradiometer
NMDR	national malaria data repository
NMP	national malaria programme
NMSP	national malaria strategic plan
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
PDMC	post-discharge malaria chemoprevention
Penta2	second dose of the pentavalent vaccine
Penta3	third dose of the pentavalent vaccine
<i>Pf</i> HRP2	<i>Plasmodium falciparum</i> histidine-rich protein-2
<i>Pf</i> PR	<i>Plasmodium falciparum</i> prevalence rate
PHC	primary health care
PMC	perennial malaria chemoprevention
PR	prevalence rate
QALY	quality-adjusted life years
QC	quality control
QT	quality testing
RDT	rapid diagnostic test
SMC	seasonal malaria chemoprevention
SNT	subnational tailoring
SOW	scope of work
SP	sulfadoxine pyrimethamine
SWOT	strength, weaknesses, opportunities, threats
TDA	targeted drug administration
TOR	terms of reference
TPR	test positivity rate
UHC	universal health coverage
VMW	village malaria worker
WHO	World Health Organization

# Glossary

Glossary definitions were aligned with the *WHO malaria terminology, 2021 update (1)*, and where definitions were not available, working versions were developed and refined with expert input to ensure clarity and consistency.

<b>baseline (or malaria baseline)</b>	The malaria burden that would be present in a specific area if there were no control activities. Also known as “intrinsic malaria transmission level”.
<b>case, imported</b>	Malaria case or infection in which the infection was acquired outside the area in which it is diagnosed.
<b>case, locally acquired</b>	A case acquired locally by mosquito-borne transmission <i>Note:</i> Locally acquired cases can be indigenous, introduced, relapsing or recrudescence; the term “autochthonous” is not commonly used.
<b>economic evaluation</b>	Economic evaluations (such as cost-effectiveness analysis) compares the relative costs and outcomes (or effects) of different courses of action, offering a systematic approach to compare the relative value of different options by assessing the health outcomes (or effects) achieved for the resources invested.
<b>effective coverage</b>	The fraction of an area’s at-risk population that is fully protected by the malaria intervention of interest. It takes into account factors that may reduce the efficiency of an intervention, including coverage gaps, effectiveness gaps and residual transmission gaps. <ul style="list-style-type: none"><li>Coverage gaps are those that limit the proportion of the population reached by the intervention.</li><li>Effectiveness gaps are those that limit the impact of the intervention in those already covered by the intervention (e.g. resistance to insecticide may reduce the effectiveness of standard insecticide-treated nets [ITNs]).</li><li>Residual transmission gaps are those related to the persistence of malaria transmission even when the intervention is implemented at full coverage and is working at maximum effectiveness.</li></ul>
<b>entomological inoculation rate</b>	Number of infective bites received per person in a given unit of time, in a human population <i>Note:</i> This rate is the product of the “human biting rate” (the number of bites per person per day by vector mosquitoes) and the sporozoite rate (proportion of vector mosquitoes that are infective). At low levels of transmission, the estimated entomological inoculation rate may not be reliable, and alternative methods should be considered for evaluating transmission risk.
<b>geospatial analysis</b>	The use of geographic information systems and geospatial data to measure, examine and visualize spatial patterns, relationships and trends. It often includes statistical methods and/or artificial intelligence.
<b>incidence, malaria (clinical malaria incidence)</b>	Number of newly diagnosed malaria cases during a defined period in a specified population.
<b>intervention combination</b>	The combination of preventive, diagnostic and treatment strategies deployed to control or eliminate malaria in a specific setting.
<b>macroplanning</b>	A top-down planning process carried out at national level, based largely on assumptions and standard formulae and parameters.

<b>malaria elimination</b>	Interruption of local transmission (reduction to zero incidence of indigenous cases) of a specified malaria parasite in a defined geographical area as a result of deliberate activities. Continued measures to prevent re-establishment of transmission are required.
<b>malaria risk</b>	The probability of malaria infection occurring in a specific population or area over a certain period.  <i>Note:</i> malaria risk can be measured using metrics such as prevalence, incidence and mortality.
<b>microplanning</b>	A bottom-up planning process that gathers critical operational and financial information from the lowest possible levels. Microplanning is carried out at the implementation level. Compared with macroplanning, microplanning uses more concrete, detailed and up-to-date information provided by local health facility staff and other relevant actors at community level (community health workers, local leaders, representatives from implementing partners, community and civil society organizations, etc.) (2).
<b>modelling (or mathematical modelling)</b>	Analytical methods used to simulate malaria transmission dynamics and predict disease risk and burden. Underlying epidemiological processes are modelled, enabling the comparison of alternative scenarios to inform intervention planning.
<b>operational unit</b>	The geographical unit at which operational decisions are made. This could consist of regions, districts, health facility catchment areas or communities.
<b>optimization (or resource optimization)</b>	The optimal allocation of resources (e.g. time, money) to achieve objectives within given constraints.  In the context of malaria, optimization is about ensuring the most efficient and effective use of resources to deliver the most impact on malaria burden under set financial constraints. This may involve scaling back or removing low-priority interventions from the strategic plan, reallocating interventions based on cost-effectiveness, and removing operational inefficiencies.
<b>prevalence, malaria (parasite prevalence)</b>	Proportion of a specified population with malaria infection at a specific point in time.
<b>prioritization (or intervention prioritization)</b>	The ranking of objectives, activities and interventions based on criteria such as importance, urgency and impact.  In the context of malaria, the ranking of individual interventions and combinations of interventions considers different local factors, including epidemiological and ecological conditions and previous interventions, to maximize impact on reducing malaria burden.
<b>residual transmission</b>	Persistence of malaria transmission following the implementation in time and space of a widely effective malaria programme.
<b>stratification (or malaria stratification)</b>	The classification of geographical areas or localities according to epidemiological, ecological, social and economic determinants for the purpose of guiding malaria interventions.  It can include <i>risk stratification</i> (i.e. classification of geographical areas or localities according to factors that determine receptivity and vulnerability to malaria transmission) and/or <i>intervention stratification</i> (i.e. classification based on eligibility and other criteria, such as endemicity criteria).
<b>subnational tailoring (SNT) of malaria interventions and strategies</b>	The use of local data and contextual information to determine the appropriate combinations of interventions and strategies and best allocation of resources for a given area, such as a district, health facility catchment or village, for maximum impact on transmission and burden of disease, within the context of value-based health-care delivery through an inclusive process.

<b>surveillance</b>	Continuous, systematic collection, analysis and interpretation of disease-specific data and its use in planning, implementing and evaluating public health practice.  <i>Note:</i> surveillance can be done at different levels of the health-care system (e.g. health facilities, the community), with different detection systems (e.g. active or passive case-based detection) and sampling strategies (e.g. sentinel sites, surveys).
<b>transmission continuum</b>	A concept describing the range of malaria transmission intensities, from high to zero, and the corresponding strategic needs for intervention.
<b>transmission level (high, moderate, low, very low)</b>	High, moderate, low and very low transmission levels are defined using the following thresholds: <ul style="list-style-type: none"> <li>• high: 450 cases per 1000 population per year or <i>Plasmodium falciparum</i> prevalence rate (<i>PfPR</i>) 35%</li> <li>• moderate: 250–450 cases per 1000 population per year or <i>P. falciparum/P. vivax</i> PR = 10–35%</li> <li>• low: 100–250 cases per 1000 population per year or <i>P. falciparum/P. vivax</i> PR = 1–10%</li> <li>• very low: &lt; 100 cases per 1000 population per year or <i>P. falciparum/P. vivax</i> PR &gt; 0 and &lt; 1%.</li> </ul> Thresholds are indicative and should be tailored to local contexts.
<b>transmission, perennial</b>	Transmission that occurs throughout the year with no great variation in intensity.
<b>transmission, re-establishment of</b>	Renewed presence of a measurable incidence of locally acquired malaria infection due to repeated cycles of mosquito-borne infections in an area in which transmission had been interrupted.
<b>transmission, seasonal</b>	Transmission that occurs only during some months of the year and is markedly reduced during other months.
<b>universal coverage</b>	Access to and use of appropriate interventions by the entire population at risk of malaria.

## References

1. WHO malaria terminology, 2021 update. Geneva: World Health Organization; 2021 (<https://apps.who.int/iris/handle/10665/349442>).
2. Microplanning guidelines: additional information to accompany AMP toolkit. Geneva: Alliance for Malaria Prevention; 2018 (<https://allianceformalaria-prevention.com/resources/amp-toolkit/microplanning/>).

# Executive summary

This manual provides guidance for national malaria programmes (NMPs), subnational programme teams and their partners to adapt World Health Organization (WHO) recommendations on malaria interventions and strategies, enabling the development and implementation of evidence-informed, locally owned strategic plans. It is designed to support the subnational tailoring (SNT) of malaria interventions and strategies, recognizing the considerable heterogeneity in malaria transmission and burden within countries. This approach is essential for achieving the best possible returns on investment.

The document is underpinned by core public health principles, including country ownership, universal health coverage (UHC), health priority-setting, and value-based health-care planning. It builds upon experiences from the “high burden to high impact” approach and captures expertise from countries implementing end-stage elimination activities and from experts in the field.

The manual aims to address the complexities of malaria transmission dynamics, which vary due to climate, ecology, socioeconomic development, urbanization and health systems. The use of local data and contextual information enables the selection of appropriate combinations of interventions at the subnational level. The SNT process is not only informed by data and evidence but is also deliberative and political, requiring system-wide and multistakeholder participation. The SNT process is not separate from existing planning processes, but rather a way to enhance and support existing processes.

This manual provides comprehensive guidance on the SNT of malaria interventions and strategies, intended to support NMPs in optimizing their response based on local contexts. It opens with an introduction that presents the rationale for tailoring malaria responses at the subnational level, outlines core malaria concepts relevant to SNT, and defines the principles underpinning this approach. The manual then details a step-by-step implementation process aligned with and ideally embedded within national planning cycles, such as malaria programme review and strategic planning processes. These steps are planning and ensuring preparedness; assembling and managing data; conducting situation analyses; stratifying malaria risk and its determinants; tailoring combinations of eligible interventions to the local context and prioritizing individual and combination interventions; forecasting the impact of intervention combinations; selecting strategic scenarios for the national malaria strategic plan (NMSP); optimizing scenarios within the resource constraints of the costed operational plan; and delivering services with monitoring and evaluation of impact. Country examples are provided to illustrate key steps in the SNT process.

The manual addresses capacity-strengthening needs for SNT, offering practical considerations for building institutional and technical competencies. The concluding chapter summarizes the main messages and reinforces the integration of SNT into NMP planning.

A robust set of annexes supports implementation with tools and technical resources: terms of reference for the SNT team lead; a proposed data checklist; a conceptual framework of the malaria transmission continuum; methodologies for estimating malaria baselines and effective coverage of interventions; detailed guidance on stratification metrics and determinants; intervention-specific tailoring strategies (e.g. case management, vector control, chemoprevention, vaccines); the use of mathematical modelling in decision-making; costing; cost-effectiveness analyses; and monitoring and evaluation checklists tailored to the SNT process.

Together, these resources equip users with the tools and analytical approaches necessary to guide locally adapted and evidence-informed malaria responses and ensure future SNT exercises are driven by experience and evidence.

This manual is primarily intended for use by:

- NMPs and their implementation partners across all transmission settings, but especially in moderate to high transmission settings;
- subnational entities responsible for coordinating implementation activities and engaging with communities on health priority-setting;
- technical experts who support countries in the SNT of interventions; and
- funding agencies supporting malaria interventions.

Finally, this manual will be updated as new recommendations and strategies are developed, and as new experiences and methods emerge. Continuous feedback from NMPs and their implementing partners, researchers and funders will be essential to ensure that lessons from the field inform the tailoring of interventions across the transmission continuum.



# Chapter 1

# Background



## 1.1 Context

A cornerstone of the *Global technical strategy for malaria 2016–2030* (GTS) is the use of enhanced surveillance and local data to inform decision-making by national malaria programmes (NMPs) and partners (1). Across the transmission continuum, data-driven approaches enable the design of locally tailored intervention combinations that address unique local (district or community) needs, as detailed in the WHO malaria guidelines (2). Malaria's complex and dynamic transmission patterns are shaped by ecological, climatic and socioeconomic factors, the health system and interventions (including those interventions not delivered by the health system such as school-based health education), creating significant heterogeneity and complexity across locations and time. This variability (in addition to other factors such as time and funding constraints) necessitates subnationally tailored responses informed by local data to optimize intervention selection and delivery and underscores the importance of embedding subnational tailoring (SNT) within national malaria strategic planning (N MSP) cycles.

This manual equips NMPs and their partners to adapt WHO recommendations into evidence-based, locally relevant strategic plans. Drawing on practical experience from the "high burden to high impact" approach (3) – an initiative aimed at directing resources to where they are most needed – this manual integrates insights from malaria-eliminating countries and other global efforts to optimize resource allocation and drive impact.

With recent advances in data systems and the growing adoption of digital technologies such as data repositories and DHIS2, stakeholders can increasingly leverage robust surveillance and local data to generate critical outputs such as stratification maps, intervention impact forecasts and operational assessments. These tools guide strategic planning, resource allocation and intervention targeting, ensuring the efficient use of available, usually limited, resources. More specifically, lessons from applying SNT methods in previous national malaria planning cycles between 2019 and 2023 and recently published WHO prioritization guidelines (3) inform the principles and practical approaches provided in this manual for tailoring planning and implementation processes for malaria control and elimination across diverse transmission settings.

### Box 1. Strategic foundations for SNT

Universal health coverage (UHC), health priority-setting, value-based health services, and the Paris Declaration on Aid Effectiveness are foundational frameworks and initiatives for SNT in malaria programme design and implementation. Together, these concepts ensure health system strategies and approaches are inclusive, equitable, sustainable and aligned with both local and global health priorities.

**UHC** prioritizes providing services to those most in need to ensure all individuals and communities can access essential health services – from health promotion and prevention to treatment, rehabilitation and palliative care – without financial hardship (4). UHC requires a well-supported and equitably distributed health workforce. Malaria remains one of the most significant maternal and child health conditions in primary health care (PHC). By integrating malaria services into PHC systems, UHC facilitates equitable access to effective interventions and supports sustainable progress against the disease.

**Health priority-setting** is a process that ensures resources are allocated to address a country's most pressing health needs in a manner that is fair, efficient and sustainable (5). Health priority-setting involves making decisions based on principles of inclusivity, evidence-based planning and alignment with national health strategies. It is guided by the following goals:

- maximizing health benefits – allocating resources where they will achieve the greatest overall health impact;
- ensuring equity – addressing the needs of the most vulnerable and underserved populations, including those living in hard-to-reach areas and humanitarian settings;
- promoting sustainability – balancing short-term gains with long-term health system resilience and capacity; and
- enhancing efficiency – optimizing the use of resources to achieve the best possible outcomes with minimal waste.

Health priority-setting considers factors such as disease burden, intervention coverage, cost-effectiveness, feasibility and social acceptability, enabling decision-makers to prioritize interventions that yield the highest value for health. In the context of NMPs and SNT, health priority-setting ensures that resources are directed towards evidence-based, cost-efficient interventions tailored to local contexts, contributing to sustainable and equitable health outcomes while aligning with broader health sector plans (ensuring services and interventions are designed around the needs of people).

**Value-based health services** focus on achieving the best health outcomes for populations through efficient resource allocation and patient-centred care. They build on the value-for-money principles of economy, efficiency, effectiveness, equity and cost to ensure investments in health services translate directly to meaningful health impacts for patients and communities (6). Value-based health services represent a shift from "what is the matter with people" to "what matters to people", placing patients at the core of care delivery and emphasizing prevention, responsiveness and equity. Within value-based health services, the "3D approach" – decision-making by progressing through data, dialogue and decisions – facilitates evidence-based, inclusive strategies that align with community needs.<sup>1</sup> By integrating value-based health services principles, NMPs can enhance the delivery of effective interventions, promote financial protection and ensure equitable access to care, particularly for vulnerable and underserved populations. This approach supports cost-efficient malaria interventions (a critical step in the SNT process, described in later sections) and sustainable improvements in broader health systems and outcomes.

Health priority-setting in low- and middle-income countries is influenced not only by national decision-makers but also by external health financing agencies, as many of these countries rely on international funding to combat malaria. While this external investment has been instrumental in driving progress against malaria over the past two decades, misalignments between country and donor priorities can sometimes lead to distortions, inefficiencies and reduced impact.

<sup>1</sup> Data reflect criteria such as burden, cost-effectiveness, budget impact, fairness and acceptability. Dialogue ensures legitimacy, accountability, transparency and inclusiveness. Decisions are guided by a clear legal mandate and incorporate citizens' voices.

To address these challenges, in 2005 the Second High Level Forum on Aid Effectiveness, coordinated by the Organisation for Economic Co-operation and Development, endorsed the Paris Declaration on Aid Effectiveness, establishing five key principles: country ownership, alignment, harmonization, managing for results, and mutual accountability (principles that align closely with those of SNT; see section 1.3) (7). The Accra Agenda for Action, adopted in 2008, reaffirmed these commitments and emphasized the need for stronger partnerships among stakeholders to ensure aid is more effective and aligned with national priorities (8). These principles remain highly relevant today, as the global aid landscape faces increasing volatility – including shifting donor priorities, reduced predictability of funding, and political uncertainties affecting major bilateral agencies such as those dependent on United States government funding.

## 1.2 Rationale for SNT of malaria interventions and strategies

Malaria transmission is inherently heterogeneous, shaped by ecological and climatic factors, and further influenced by human activities including malaria interventions and socioeconomic development. This dynamic and context-specific epidemiology necessitates adaptive planning and implementation approaches. Timely and high-quality data are essential to inform the tailoring of interventions to ensure adequate coverage and maximum effectiveness (1). The following factors provide the rationale for SNT.

- Malaria transmission varies geographically, even within high-burden countries, and exhibits temporal variations, including seasonal and long-term trends.
- Climatic and ecological factors such as temperature, rainfall and humidity contribute significantly to transmission heterogeneity. Anthropogenic factors, including health system performance, intervention impact, urbanization, migration, population mobility and agricultural activities, further modulate transmission dynamics.
- Existing malaria interventions can be cost-effective but have varying impacts on infection rates, disease severity and mortality depending on local conditions, operational feasibility of implementation, capacity of the health-care system, and changes over time and space.
- Best outcomes are achieved by matching interventions to local conditions rather than applying everything everywhere, ensuring resources are utilized to achieve the greatest impact. This approach strengthens strategic focus by directing efforts to interventions that will yield the largest reductions in morbidity and mortality.
- Given the heterogeneity of malaria transmission over location and time and the varying impact of interventions, a strategic approach will mean some locations are of higher priority for interventions than others in a given context. Malaria programmes can achieve greater impact by focusing resources on the highest priority interventions and locations, especially when resources are constrained.

**SNT** is the use of local data and contextual information to determine the appropriate combination of interventions and strategies and best allocation of resources for a given area, such as a district, health facility catchment or village, for maximum impact on transmission and burden of disease, within the context of value-based health-care delivery through an inclusive process.

SNT plays a critical role in maximizing the impact of interventions by ensuring that efforts are concentrated where they are most needed and most likely to succeed. SNT leverages advances in analytical methods and malaria epidemiology to enhance intervention precision. By recognizing malaria's local heterogeneity and tailoring responses accordingly, resources can be allocated more effectively to achieve significant public health impacts. This approach builds on global efforts to refine strategies that address the complex and context-specific nature of malaria transmission (3).

The SNT process is integral to the national strategic planning and implementation cycle, serving as a bridge between broad national goals and localized action. SNT informs and strategic direction and programmatic activities by providing evidence-based guidance for allocating resources most effectively, thereby strengthening the development of the national malaria strategic plan (NMSP), and single costed operational plan, or refining existing ones. Effective SNT ensures interventions are designed, prioritized and implemented to maximize their impact. The SNT process addresses five fundamental questions necessary to guide SNT (Box 2).

## Box 2. Key questions guiding SNT during the malaria planning and implementation cycle

### Where, when and for whom do we intervene?

Answering this question requires an understanding of malaria risk factors (vector species, transmission intensity, burden, age patterns, high-risk groups, underserved and hard-to-reach populations etc.) as well as their natural (climatic and ecological) and anthropogenic determinants (previous interventions, and land use and other human activities) within a geographical unit and/or time of interest. SNT recognizes that not all areas contribute equally to national burden or represent equal opportunities for impact.

### Which interventions or strategies should we use?

Answering this question requires an understanding of the interventions (and combinations of intervention)– routine case management, ITNs, indoor residual spraying (IRS), integrated community case management (iCCM), seasonal malaria chemoprevention (SMC), PMC, IPT, malaria vaccine, MDA etc. – and strategies that have the biggest impact on malaria transmission, morbidity and mortality within a given context. Effects will vary over time, across geographies, transmission settings and population groups, and according to the PHC system. Both baseline conditions (or periods with limited intervention coverage) and current transmission intensity and risks should be understood (see Annex 3 on the malaria transmission continuum).

Determining which interventions to use, where, when and for whom is foundational to the development of the NMSP. This process should follow WHO recommendations, be tailored to local contexts, and be informed by operational realities and resource constraints. Prioritization may be required. This involves systematically ranking interventions and combinations of interventions, or geographies, for malaria burden reduction. This ranking process should incorporate context-specific variables, including epidemiological profiles, ecological characteristics, and the implementation history of previous interventions (3). Although various areas may benefit from targeted interventions, resources should be strategically focused on regions where the potential for health impact is highest. The NMSP will ultimately be costed to quantify the financial requirements necessary for effective implementation.

### **Which interventions can we afford, where, when and for whom?**

Answering this question involves determining the most efficient and effective way to use resources to achieve the greatest impact on the malaria burden, considering both domestic and external funding while ensuring equity. Ideally, external funding should align with national priorities and support the strategic combination of interventions outlined in the NMSP.

Where funding is constrained, optimization of the NMSP may involve scaling back or removing low-priority interventions, reallocating resources based on cost-effectiveness and evidence from modelling, and addressing operational inefficiencies to improve delivery (e.g. via integration and coordination of SMC and vaccine campaigns).

### **How, when and for whom do we deliver interventions?**

Discussions on delivery mechanisms typically occur during the strategic planning process. The choice of delivery approach is shaped by the local context and guided by cost considerations to ensure the most efficient use of resources. This includes estimating the impact and cost-effectiveness of different delivery approaches. Relevant systems and programmatic capacities – such as health workforce capacity and supply chain performance – are also critical to decision-making around SNT and the selection of delivery mechanisms.

### **How do we define and monitor the impact?**

It is crucial to monitor the impact of interventions, identify and address gaps, and refine the NMSP accordingly. However, attributing impact is complex, as both intervention and non-intervention factors occur simultaneously. Their combined effects are difficult to disentangle, especially when information systems are weak. Since the SNT process relies on available data at any given time, it also serves as a valuable tool for identifying necessary investments in surveillance, monitoring and evaluation systems, including the surveillance of biological threats. These investments can be tailored subnationally based on priority areas.

## 1.3 Malaria concepts relevant to SNT

### 1.3.1 Malaria transmission continuum

The malaria transmission continuum describes the varying levels of malaria intensity and burden across different settings, ranging from areas with high, stable transmission to those approaching malaria elimination and prevention of re-establishment of transmission (1). The continuum and the potential for malaria transmission are influenced by a complex interaction of factors, including:

#### **environmental and climatic factors:**

- temperature and rainfall;
- geography and topography of the land;
- amount and type of agriculture or land cover; and
- number of water bodies;

#### **vector and parasite characteristics:**

- the mosquito vector species, abundance and behaviour;
- the *Plasmodium* species; and
- resistance to insecticide and antimalarial drugs;

#### **biological, human and social factors:**

- how people spend their time in these places and vector feeding times;
- population demographics and gender norms;
- mobility and migration pattern;
- marginalized or displaced populations;
- host immunity (usually influenced by transmission intensity); and
- structural inequalities, including poverty, education level and discrimination, that affect malaria risk and access to services;

#### **infrastructure and systems:**

- availability, accessibility, acceptability and quality of health services;
- quality of housing; and
- the types and coverage of existing malaria interventions and whether they reach populations most in need.

Countries or regions move along the malaria transmission continuum as malaria control efforts reduce transmission intensity, leading to lower case incidence, elimination and prevention of reintroduction. WHO emphasizes tailored interventions at each stage, ensuring that surveillance and response strategies are adapted to the local epidemiological context (1).

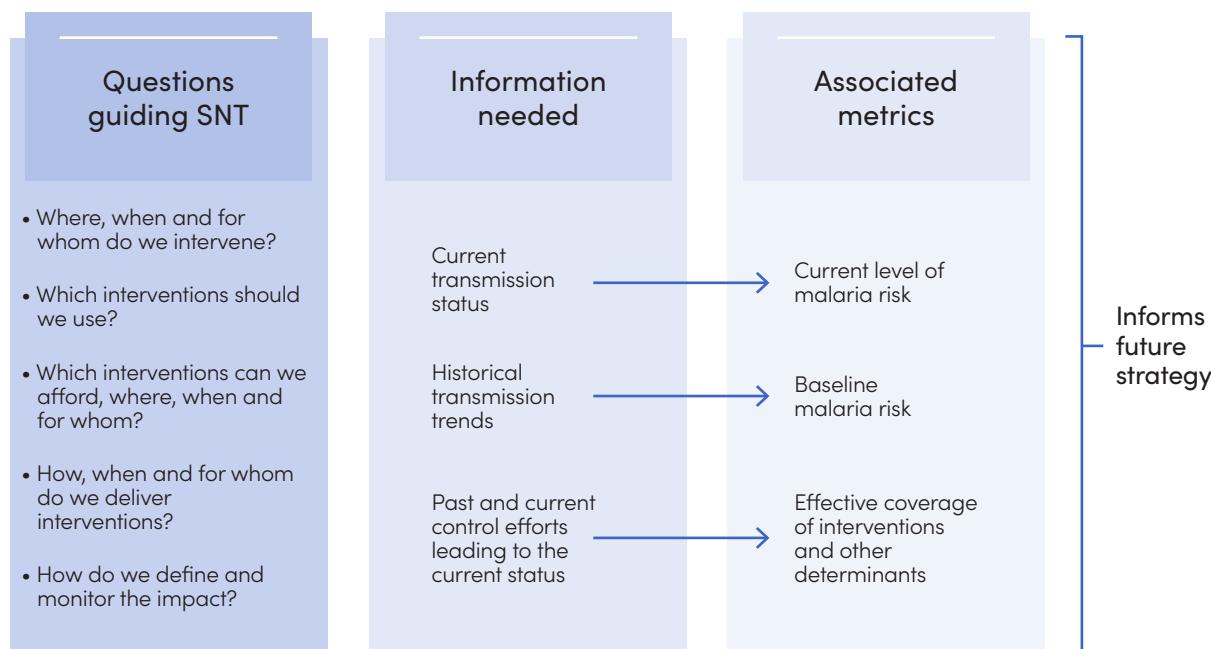
To address key questions guiding SNT (Box 2), the NMP needs to understand current and historical malaria transmission and past and present interventions.

1. **Current levels of transmission** across the country, capturing as much information as possible about variation in transmission, burden and any other variables relevant to intervention impact (e.g. vector species, seasonality, importation rate, underserved populations) at the spatial resolution of the operational unit of decision-making (though variation *within* the unit is also likely to be important).

- 2. Historical transmission trends.** Spatial and temporal baseline levels of transmission that would exist in the absence of any intervention, accounting for any changes in variables (e.g. changes in climate or ecology, humanitarian crisis and changes in human mobility and migration patterns) affecting the intrinsic receptivity and vulnerability (or importation risk) of areas to transmission.
- 3. Current control efforts.** The type, scale, timing, geographical distribution, uptake and delivery mechanisms of all current malaria interventions and strategies, including data on coverage, quality, effectiveness, and implementation challenges.
- 4. Previous control efforts** that impact transmission intensity and burden, including their spatial distribution, timelines, their uptake and the costs associated with their implementation as well other direct and indirect determinants of the change in malaria.

This information supports various associated metrics and in turn decisions about the interventions and strategies that need continuation and scaling up, those that should be scaled back, and any new interventions that should be introduced. These decisions depend on their effect on malaria transmission and burden and shape the future strategy (Fig. 1).

**Fig. 1. Key questions guiding SNT, information needs and associated metrics**



More information about the malaria transmission continuum, estimation of baseline and current risk of malaria can be found in Annex 3.

### 1.3.2 Effective coverage

Analysis of the impact of past control efforts is critical to projecting future impact and requires an understanding of effective coverage. Effective coverage is the fraction of an area's at-risk population that is fully protected by a malaria intervention. The impact of malaria interventions in the field is usually lower than that observed during epidemiological studies and experimental trials. The gaps in effective coverage are:

- **coverage gaps** that limit the proportion of the population reached by the intervention, including health system gaps, the effects of social determinants (e.g. financial constraints that limit access to paid services), and displacement and remoteness of populations;
- **effectiveness gaps** that limit the impact of the intervention in those it covers (e.g. the resistance of vectors to insecticide may reduce the effectiveness of standard insecticide-treated nets (ITNs)); and
- **residual transmission gaps** related to the persistence of malaria transmission even when the interventions are implemented at full coverage and are working at their maximum effectiveness (e.g. asymptomatic infections will lower the effective coverage of routine case management).

Usually, coverage or use of interventions describes the fraction of population covered; for example, households or individuals who own a net, those who slept under a net the night before the survey, those who have had their households sprayed, those who received chemoprevention or a vaccine, or those who attend health facilities when they are sick. However, individuals may not be fully protected or cured; for example, they may not always use the net they own when they are at highest risk of exposure, the insecticide may have lost potency, a person may not take a full preventive or curative dose of effective drugs, a child may not complete their vaccination series or the health facility may have a stock out of effective drugs. Additionally, access to timely and quality diagnosis and treatment may be hindered by systemic issues such as distance to health facilities and service fees. The fraction of the population effectively protected from transmission or disease is therefore likely to be substantially lower than the fraction that has access to these interventions. More information about estimating the effective coverage of interventions (vector control, case management, chemoprevention and vaccine) can be found in Annex 4.

### 1.3.3 Informed strategy

Quantifying the malaria transmission continuum and the factors driving it is crucial to guide future strategy. This is demonstrated by comparing Fig. 2 and Fig. 3, which illustrate interventions and outcomes for four at-risk populations of approximately the same size, showing baseline transmission and current and future transmission risks based on the impact of all previous strategies and the current one. In Fig. 2a, the levels of baseline transmission in the four populations were, respectively, very high, high, moderate and low transmission. Higher impact interventions were used in the top two strata than in the lower two strata in the implementation periods before the current planning cycle. As the top two strata were those with the highest baseline transmission, this approach reflected an equitable and effective strategy, and was likely optimal given the information available at the time. Fig. 2b shows the risk of basing a future strategy

on current risk without accounting for heterogeneity in the baseline levels of transmission and the effects of previous interventions. In the boxed section of Fig. 2b, it is clear that, on the basis of current risk, more resources have been dedicated to the population with moderate baseline transmission and fewer resources to the population with high baseline transmission. As a result, despite dedicating a higher level of resources overall to malaria control, this strategy is both less equitable, with fewer resources dedicated to the setting with higher baseline, and less effective, with resurgence in the higher baseline strata cancelling out progress in the lower baseline strata.

**Fig. 2. Relying only on current risk can lead to inequitable and ineffective decision-making and outcomes**

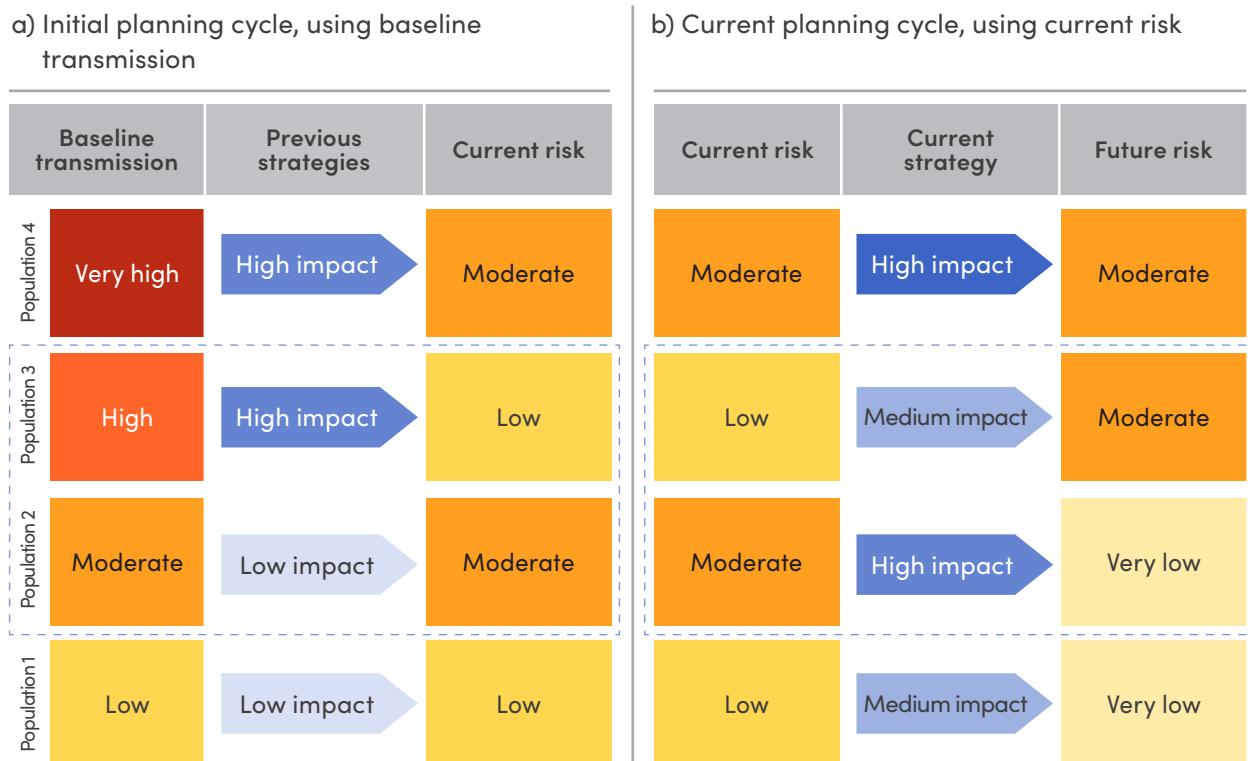
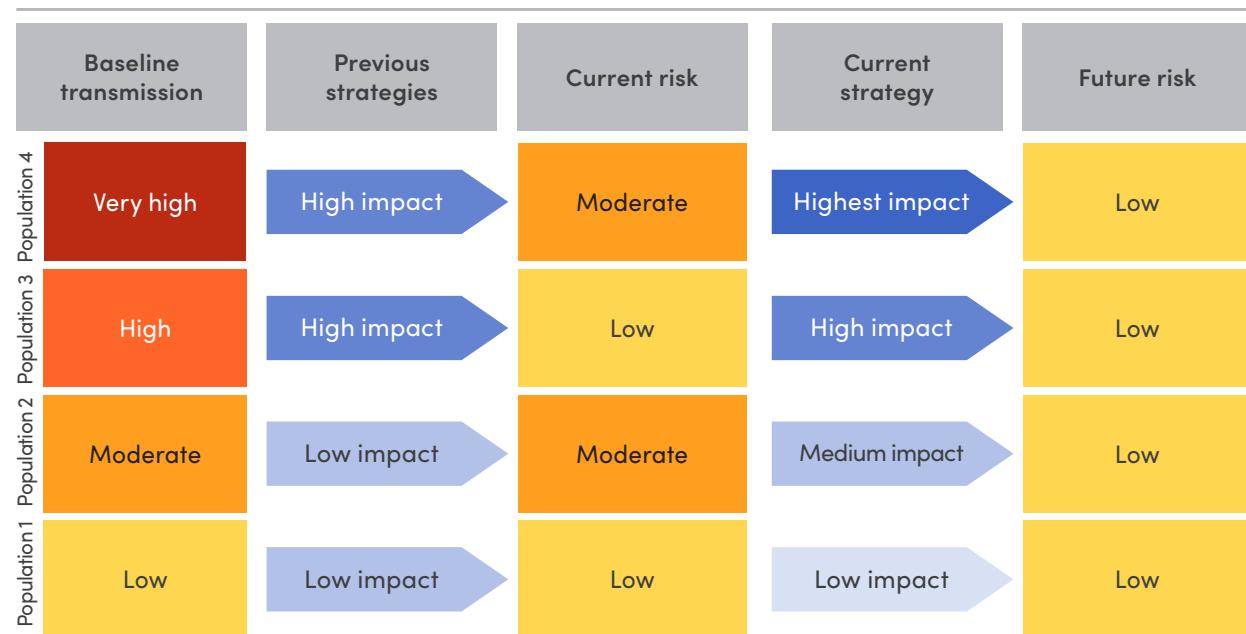


Fig. 3 depicts a scenario in which the development of the current strategy takes into account information about:

- baseline transmission (the levels before control efforts began)
- previous interventions and strategy
- current risk levels.

This approach enables more equitable and effective distribution of resources, and ensures gains are maintained while prioritizing additional resources to areas that are currently most at risk, leading to sustainable reductions in transmission and burden.

**Fig. 3. Relying on information about the past and present enables more effective and equitable decision-making**



### 1.3.4 Implementation of SNT across all transmission settings, including elimination ones

SNT is applicable across all malaria transmission settings including very low, low, moderate, and high endemicity. SNT requires reliable and up-to-date data on transmission in all endemic areas. This is especially important in elimination settings. Countries nearing elimination require robust health management information systems (HMIS) capable of facilitating high-resolution data collection and routine analysis across temporal, spatial and population dimensions. This enables targeted evaluation of intervention deployment, identifying what was implemented, where, for whom, when, and with what epidemiological and operational impact. Risk stratification and tailored intervention planning must be conducted with increasing granularity. Strategic planning must incorporate cost-effectiveness analysis to guide implementation within resource constraints, and impact must be monitored through rigorous surveillance and evaluation frameworks. However, methodological adaptations may also be necessary: stratification will occur at subdistrict or focal levels; mathematical modelling to estimate intervention impact may be constrained by small number of cases leading to higher uncertainty; and alternative metrics may be required to assess progress. Furthermore, operational processes may shift from centralized, national-level planning to localized microplanning.

## 1.4 Principles of SNT

The SNT process is inherently adaptive to changing resources, contexts and data. The following principles guide the SNT approach to optimize malaria intervention planning and implementation.

- 1. Ownership.** Countries should take ownership of their malaria strategies by fostering strong national leadership, inclusive planning and institutional transparency to support flexibility, adaptation and innovation based on SNT findings. Inclusive development of strategic plans, with active country leadership, strengthens alignment with local needs and improves sustainability.
- 2. Alignment.** All external resources and support must align with national strategies and objectives. Donors should prioritize leveraging national systems, including local partners, to strengthen the health system holistically.
- 3. Harmonization.** Donor agencies and external partners should coordinate efforts to simplify procedures and share information, minimizing duplication and inefficiencies in malaria responses.
- 4. Results focus.** Impact-oriented planning should be a key focus. Countries and donors must commit to measurable health outcomes by investing in local systems that ensure high-quality data collection, analysis and utilization.
- 5. Mutual accountability.** All stakeholders, including national authorities, implementation partners and external agencies, must be accountable for their roles in achieving programme outcomes. Regular reviews and transparent reporting systems are essential to build trust and ensure collaborative success.
- 6. Capacity development.** Countries bear ultimate responsibility for enhancing their health systems. External partners should actively support this by strengthening capacity in strategic and operational planning, intervention delivery, and monitoring and evaluation systems.
- 7. Evidence-informed adaptability.** The SNT process must be grounded in strong local evidence and innovation while maintaining flexibility. Regular reviews and realignment of strategies are necessary to accommodate emerging challenges, such as market dynamics, increased intervention costs or new epidemiological trends.
- 8. Scenario-based planning.** Developing multiple implementation scenarios during the strategic planning process allows for agile reprioritization without requiring extensive reanalysis. These scenarios ensure preparedness for a range of resource levels and facilitate adaptive decision-making.
- 9. Inclusivity in decision-making.** The SNT process, which is part of NMSP development, should actively engage diverse stakeholders, including governmental and nongovernmental entities, local communities and technical experts, to build consensus on intervention priorities.
- 10. Sustainability and equity.** Strategies must be designed with a long-term view, aiming to optimize the use of available resources while addressing inequities in health access and outcomes. This approach ensures that interventions are impactful and equitable, reaching the most vulnerable populations.

## 1.5 Intended users of the manual

This manual is intended for use by:

- NMPs and their implementation partners across all transmission settings;
- subnational entities – especially in decentralized governance and decision-making systems – that are responsible for coordinating implementation activities and engaging with communities on health priority-setting;
- technical experts supporting countries in the SNT of interventions; and
- international and domestic funding agencies supporting malaria interventions.

## 1.6 Outline of the manual

The malaria planning and response system is complex. This manual aims to present practical health and health-related information to enable countries at different levels on the transmission continuum to build effective malaria control and elimination programmes using SNT. Aspects of biology, epidemiology and analytical methods are discussed briefly, but users should consult the references cited for further information.

Chapter 1 has introduced basic SNT concepts. Chapter 2 is structured in a modular format.

- Section 2.1 provides an overview of the 6–12-month process of integrating SNT implementation with the NMSP and other health programmes.
- Section 2.2 details the steps for implementing SNT.
- Section 2.3 provides an illustrative example of SNT.

Chapter 3 describes practical considerations for strengthening the capacity of NMPs to implement SNT. Chapter 4 provides a brief summing up ahead of a series of annexes that provide additional details on key malaria concepts and their technical implementation relevant to SNT data analysis and interpretation. These includes fundamentals of malaria transmission, methods for estimating baseline and current transmission, effective coverage of malaria interventions, stratification, mathematical modelling, and approaches to cost-effectiveness. The annexes outline WHO-recommended malaria interventions and strategies, along with practical approaches for adapting them to subnational contexts in terms of intervention prioritization (2,3), and include terms of reference for the SNT team lead (Annex 1); a proposed data checklist (Annex 2); a conceptual framework of the malaria transmission continuum (Annex 3); methodologies for estimating malaria baselines and effective coverage of interventions (Annex 4); detailed guidance on stratification metrics and determinants (Annex 5); intervention-specific tailoring strategies (Annex 6); the use of mathematical modelling in decision-making; costing (Annex 7); cost-effectiveness analyses (Annexes 8 and 9); and monitoring and evaluation checklists tailored to the SNT process (Annex 10).

## 1.7 Formulation of the manual

This manual was developed through an iterative, consultative and evidence-informed process, drawing on WHO's accumulated experience supporting countries to implement SNT and refining methods through multiple country applications. Relevant content was synthesized from WHO normative guidance (for example the *WHO guidelines for malaria [2]*), key concepts on malaria epidemiology and transmission determinants, peer-reviewed literature and programmatic experiences gathered through the implementation of the High Burden to High Impact (HBHI) approach. Successive drafts underwent review by WHO technical experts, national malaria programme representatives and partners, with revisions were guided by feasibility, resource implications and equity. Illustrative country examples were selected to highlight empirical outputs from the process across diverse epidemiological and programmatic settings; some draw on specific country experiences where SNT methods have been applied, while others are hypothetical (e.g. "Country X") to simplify demonstration of analytic or decision-making steps through the representation of real-life contexts. The manual is intended to be periodically updated as new evidence, interventions, recommendations and country experiences emerge.

# Chapter 2

## Implementing SNT



## 2.1 Integrating SNT with the malaria planning and implementation cycle

WHO has developed guidance for countries on the development and review of NMSPs and related programmes, operational plans and costings that are to align with national health sector plans (Fig. 4) (9-11).

**Fig. 4.** Simplified malaria strategic planning and implementation cycle



Source: Adapted from World Health Organization Regional Office for Africa (9-12).

SNT is not a separate process. Its steps are intended to align with and inform standard malaria planning and implementation processes, and it should therefore be nested within the overall malaria planning and implementation processes and timelines.

This section presents practical steps for countries to develop and monitor subnational strategic and prioritized malaria control and elimination plans. Both national and detailed subnational reviews should be considered, as these are key to subsequent subnational decisions on interventions, strategies and related programmatic activities.

Countries may consider implementing SNT during the malaria programme review, mid-term review, NMSP development and operational planning. These are the most structured and common entry points for a comprehensive SNT approach.

SNT should be an iterative and adaptive process. The following may trigger additional rounds of SNT, which should be integrated into the usual planning processes:

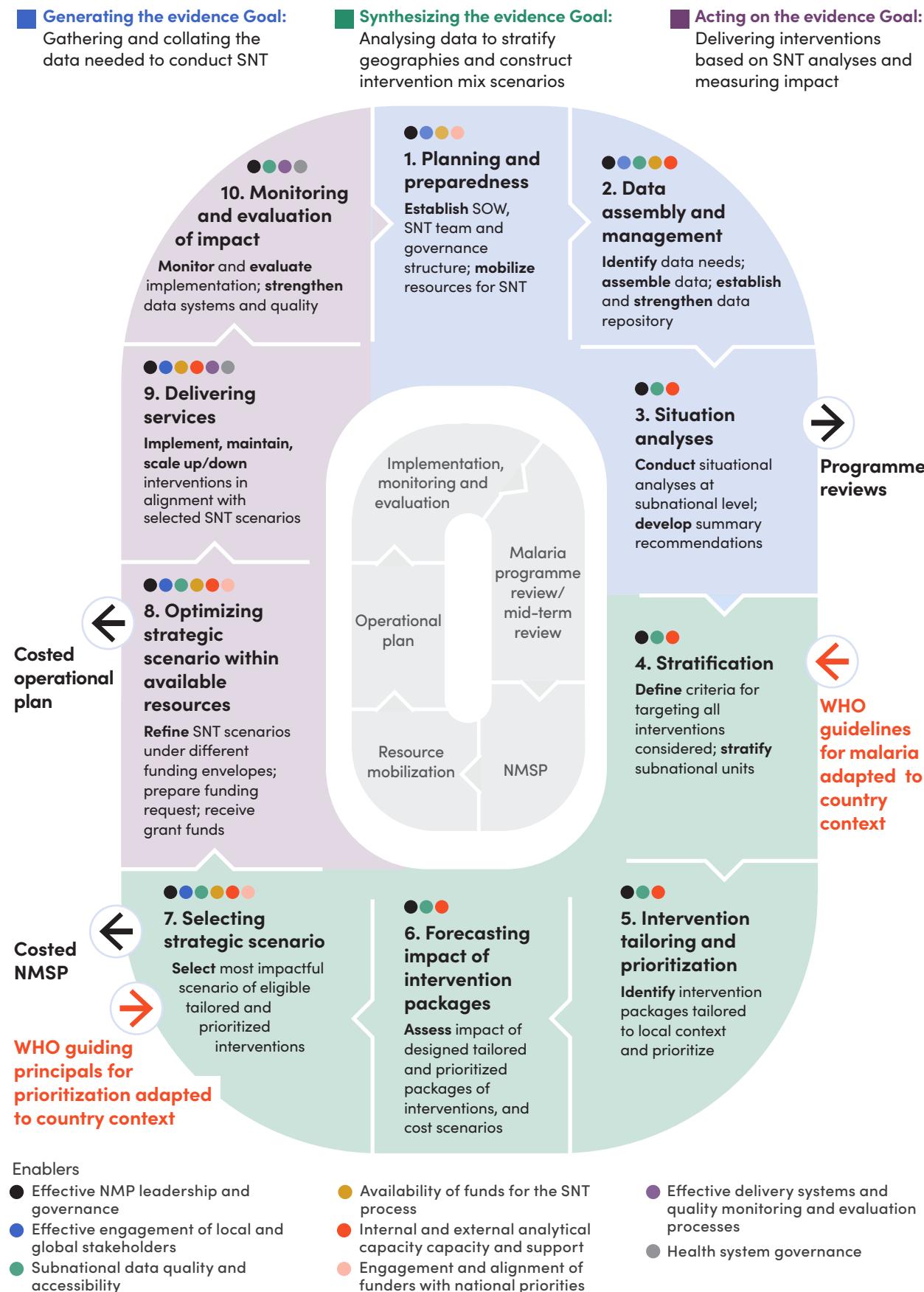
- emerging changes in malaria burden or transmission trends, such as a significant increase, decrease or shift in malaria cases, deaths or severe disease in specific areas;
- introduction of new interventions (e.g. the rollout of a new malaria vaccine or indoor residual spraying (IRS) product) or guidance (e.g. a shift in case management or diagnostic policies);
- major changes in contextual or ecological factors (e.g. changes in population movement, urbanization, natural disasters, or health system disruptions that alter malaria risk or intervention delivery); and
- substantial changes in available resources (domestic or donor) requiring reprioritization of tailored combinations of interventions.

Ideally, routine surveillance and monitoring systems should be designed to flag such triggers early, supported by periodic data reviews at national and subnational levels.

Fig. 5 proposes 10 key steps to implement effective SNT, integrated with the malaria strategic planning and implementation cycle. Table 1 provides a summary of objectives, key actions and key outputs for each step of the SNT process. Subnational stakeholders should be involved at every stage to ensure that local conditions, operational constraints and programmatic insights are incorporated into both the initial design and implementation. For example, subnational teams should review and validate data, contribute to stratification and the tailoring of intervention combinations, and provide feedback on adjustments, considering feasibility, acceptability and any unanticipated constraints.

A brief description and suggested duration of each step are provided in Box 3. While some steps are sequential, some overlap is expected; for example, step 1 (planning and preparedness) and step 2 (data assembly and management) may run concurrently for about a month, as data management activities begin while planning is finalized. Similarly, multiple impact forecasting exercises may be needed to finalize strategic plans, leading to an overlap of a few months between steps 6 (forecasting impact of intervention combinations) and 7 (developing and selecting strategic scenario for the NMSP). The recommended duration of the complete SNT process to inform strategy planning is 6–12 months.

**Fig. 5.** SNT implementation steps, and integration within the malaria strategic planning and implementation cycle



NMP: national malaria programme; NMSP: national malaria strategic plan; SNT: subnational tailoring; SOW: scope of work.  
This figure was inspired by Exemplars in Global Health (<https://www.exemplars.health/topics/malaria>).

### Box 3. SNT implementation steps – summary and duration

#### **Step 1. Planning and preparedness (1 month)**

This phase is led by the NMP and includes other government departments and national, regional and global partners. It focuses on formulating the scope of work based on the initial questions and goal of the SNT process; defining roles, responsibilities and timelines, and deciding on a governance structure, including establishing an SNT team that leverages existing staff resources; and mobilizing resources required for SNT.

#### **Step 2. Data assembly and management (3–4 months, starts concurrently with step 1)**

This phase focuses on identifying data needs to address the goal of the SNT process (including developing a data needs checklist, identifying data sources, and defining operational and temporal units for analysis) and on assembling and managing data to ensure their adequacy and quality for use. This phase is facilitated by the establishment or strengthening of a national malaria data repository (NMDR) and should involve national and subnational stakeholders for contextual validation of the data.

#### **Step 3. Situation analyses (2–3 months, starts concurrently with or 1 month after starting step 2)**

After assembly and managing data at relevant operational units, this phase focuses on conducting situational analyses using validated subnational level data and findings from operational research as relevant. Analyses focus on the impact of previous activities and interventions, and monitoring progress on current epidemiological, entomological, health systems and other indicators. This phase will lead to the development of summary recommendations for choice and implementation of interventions and should be embedded as a technical annex or subanalysis within a broader malaria programme review or mid-term review, drawing on national-level data reviews and stakeholder consultations, while adding more granular subnational insights to inform strategic and operational planning.

#### **Step 4. Stratification of malaria risk and determinants (3–4 months, starts concurrently with or 1 month after starting step 3)**

This phase focuses on stratifying malaria risk (i.e. epidemiological factors) and its determinants (interventions, demographics, ecological factors) at the relevant subnational unit against defined criteria and threshold for tailoring. These criteria will have been defined after listing all the interventions being considered for continuation, removal and/or introduction based on the situation analyses at subnational level, using normative guidance published by WHO.

#### **Step 5. Intervention tailoring and prioritization (1 month, starts after step 4 is complete)**

This phase focuses on identifying the relevant populations and combinations of interventions tailored to the stratified epidemiological and other factors identified in step 4. This phase leads to the development of malaria implementation scenarios. A scenario is a specific combination of interventions designed to suit a specific transmission context. Multiple scenarios are developed in this step and evaluated through modelling in step 6 and step 7. The scenarios developed in step 5 include:

- one scenario comprising an ideal combination of eligible interventions tailored to the subnational context, aligned with WHO recommendations, and in line with strategic goals of the NMP.

- Several scenarios with prioritized combinations of interventions that account for expected resource constraints and operational feasibility (e.g. prioritization may be based on a ranking of interventions according to malaria endemicity or potential impact), derived from the ideal tailored scenario.

#### **Step 6. Forecasting the impact of scenarios based on combinations of interventions (4–5 months, starts concurrently with step 3)**

This phase focuses on assessing the impact of the previously defined scenarios on malaria burden. The goals and objectives set at the beginning of the strategic development process provide the basis for comparing the modelled impacts of different scenarios. Modelling can simulate the impact of individual or multiple interventions and scenarios, enabling comparisons against the business-as-usual approach (i.e. the current strategy) and between new scenarios. The outputs of the modelling can be used to iteratively refine interventions and strategies, refine SNT scenarios or develop new prioritized scenarios based on impact.

#### **Step 7. Selecting strategic scenario for the NMSP (4–6 months, starts concurrently with step 3)**

This phase focuses on using the evidence generated by the previous steps to inform the NMSP. Previously designed scenarios of eligible tailored and prioritized combinations of interventions should be costed, and NMPs should select the most impactful evidence-based scenario (i.e. strategic scenario) in line with national development goals, evidence, operational and resource feasibility, established consensus and the political economy.

The strategic scenario may encompass all eligible interventions tailored to the local context and aligned with WHO recommendations or be one of the previously designed scenarios of prioritized intervention combinations. Key programmatic cross-cutting activities, such as surveillance improvements and supervision, should be included in NMSP costing.

#### **Step 8. Optimizing strategic scenario within available resources (4–6 months, starts concurrently with Step 3)**

The strategic scenario should be optimized for different resource envelopes, including the current and potential future funding. Scenarios can be optimized within different budget limits using various approaches, such as scaling back or removing low-priority interventions, reallocating resources using analyses of cost-effectiveness and modelling, and addressing operational inefficiencies. Within the broader planning cycle, the optimized scenario serves as the basis of or an input for a costed operational plan.

Using the strategic scenario as a reference against optimized scenarios can help quantify unfunded interventions and guide decision-making during reprogramming or when additional resources become available.

#### **Step 9. Delivering services, monitoring (2–4 years, depending on duration of implementation plan, starts after step 8)**

This phase is not specific to SNT but related to the implementation of the NMSP and focuses on implementing interventions and activities outlined in the costed operational plan, including maintaining, scaling up, or scaling down specific interventions. There may be opportunities for broader efficiencies in the delivery of interventions (e.g. by leveraging routine channels for distribution of interventions).

### **Step 10. Evaluation of impact (ongoing depending on duration of the implementation plan, conducted in concurrently step 9)**

Monitoring and evaluation of interventions and activities are essential to assess NMSP performance, measure impact, and inform future strategy. (This phase is not specific to SNT.) Resources should be allocated to monitoring and evaluation of delivery, supply chain systems, surveillance, data systems and quality, and the ability to use data for decision-making, embedding these elements throughout the planning and implementation cycle. While evaluation of impact focuses on measuring the outcomes and effectiveness of malaria interventions on disease burden, monitoring and evaluation of SNT (a complement to routine programme monitoring and evaluation) focus on assessing the quality, completeness and use of evidence throughout the strategic planning process to ensure informed and responsive decision-making.

The SNT process is not a linear sequence but rather an iterative approach where each step informs and influences others. It involves an iterative loop of planning, implementation and review, with decisions revisited and updated as needed, ensuring continuous improvement in malaria control and elimination. SNT is also a flexible approach and, depending on the NMP objectives (e.g. targeting interventions such as ITNs following events such as population displacements), may be implemented in part or in whole.

**Table 1. Summary of objectives, key actions and key outputs, and example templates, tools and resources for each step of the SNT process**

<b>Step</b>	<b>Objective</b>	<b>Key actions</b>	<b>Key outputs</b>	<b>Templates, tools, and resources</b>
<b>1. Planning and preparedness</b>	Align SNT activities with national priorities and build readiness for implementation.	Formulate objectives, establish teams, and identify funding.	Detailed workplan with timelines, roles and responsibilities for the SNT process	Team terms of reference (Annex 1)
<b>2. Data assembly and management</b>	Collect, organize and manage data required for SNT analysis.	Identify data sources (routine age and sex disaggregated health data, population data, entomological data, intervention coverage, climate covariates and geospatial data), clean and validate datasets, assess quality of data and integrate into a centralized system (e.g. a NMDR).	a) Comprehensive, validated dataset compiled from relevant sources b) Data quality assessment report	Data-collection forms/checklist (Annex 2), WHO Malaria Surveillance Assessment Toolkit data quality assessment tools (13)

<b>Step</b>	<b>Objective</b>	<b>Key actions</b>	<b>Key outputs</b>	<b>Templates, tools, and resources</b>
<b>3. Situation analyses</b>	Analyse malaria burden and drivers of transmission to inform intervention tailoring.	Map baseline and current transmission, assess health system readiness, and identify high-burden areas and transmission hotspots.	Analytical report summarizing current and historical geographical and temporal malaria burden, population at risk, transmission drivers including impact of interventions, and programme performance	Practical manual for malaria programme review and malaria strategic plan mid-term review (10)
<b>4. Stratification of malaria risk and its determinants</b>	Identify appropriate interventions and strategies based on local contexts.	Compile potential interventions, assess feasibility, and align with malaria burden and resource availability.	Comprehensive list of interventions and strategies with eligibility and targeting criteria	List of criteria (see Table 3); WHO Malaria Toolkit app (14)
	Stratify malaria burden and transmission drivers to refine intervention targeting.	Develop stratified maps of risk, incorporating ecological, entomological and health system readiness indicators.	Stratified risk maps of malaria by operational unit	Example risk stratification maps (15, 16), Annex 5 (stratification)
<b>5. Intervention tailoring and prioritization</b>	Develop tailored and prioritized intervention combinations based on stratified malaria risks and other determinants.	Design intervention combinations and provide recommendations for subnational levels.	Scenarios of intervention combinations tailored to local context risks, and prioritized using factors such as malaria epidemiology	Guiding principles for prioritizing malaria interventions in resource-constrained country contexts to achieve maximum impact (3)
<b>6. Forecasting impact of intervention combinations</b>	Evaluate potential impact and cost-effectiveness of different intervention scenarios (tailored and prioritized).	Model intervention combinations, analyse cost-effectiveness, and identify trade-offs.	Comparative analysis of scenario-based projections of impact with costs and equity considerations	Annex 7

<b>Step</b>	<b>Objective</b>	<b>Key actions</b>	<b>Key outputs</b>	<b>Templates, tools, and resources</b>
<b>7. Selecting strategic scenario for the NMSP</b>	Finalize and include the most impactful evidence-based combinations of interventions (i.e. the strategic scenario) in line with national vision, goals and practical feasibility.	Conduct stakeholder consultations and finalize prioritized scenarios.	Costed NMSP, with funding gap analysis and resource mobilization strategy	Manual for developing national malaria strategic plans (11)
<b>8. Optimizing strategic scenario with available resources</b>	Develop a rationalized, costed plan for intervention allocation within budget constraints.	Assess budget scenarios, optimize costs of strategic plans against different funding envelopes, and document trade-offs.	a) Finalized and costed operational plan with optimized interventions b) Documentation of trade-offs made during optimization	Annex 9 User guide for the malaria strategic and operational plan costing tool (9)
<b>9. Delivering services</b>	This is part of the NMP implementation and not SNT specific.			
<b>10. Monitoring and evaluation of SNT (complementary to monitoring and evaluation of interventions and impact)</b>	Ensure effective implementation of SNT steps, enabling adaptive strategies based on evidence and context.	Document learnings and challenges from the SNT process/steps.	SNT monitoring and evaluation framework with indicators, targets, and data sources	Annex 10

## 2.2 SNT implementation steps

### 2.2.1 Step 1: Planning and preparedness

The SNT process is underpinned by the principle that countries should set their own strategies to respond to their own health priorities. It is not a standalone process, but one that is integrated into standard processes, such as malaria programme reviews and development of NMSPs. Strong national and subnational leadership and coordination mechanisms are needed to ensure that all relevant voices are heard and that decisions are made through a participatory and transparent process.

Led by the NMP and including other government departments and national, regional and global partners, this phase focuses on deciding the governance structure, including establishing an SNT team leveraging existing staff resources (aligning with existing governance for NMSP development), formulating the scope of work based on the initial questions and goal of the SNT process, roles, responsibilities and timelines, and mobilizing resources for SNT.

### 2.2.1.1 Governance structure

The composition of the SNT team depends on the malaria ecosystem in the country. Existing teams, such as malaria programme review teams or technical working groups for surveillance and data use, provide a foundation of expertise and a coordination mechanism that can be leveraged for SNT efforts. The team should be led by the NMP manager or surveillance focal person within the NMP. The leading focal persons will be responsible for the identification of all other relevant stakeholders that should be included in the decision-making process. The team should include representatives with the following expertise.

- **Programmatic decision-making.** Experts in national health policy-making processes can facilitate the adoption of the SNT outputs in national sectoral plans and align donors with these plans. This group of experts usually includes representatives from the department of planning and budgeting within the ministry of health, the NMP manager and focal persons within the NMP responsible for case management, vector control, chemoprevention, surveillance, monitoring and evaluation, social behavioural change and communication, health statistics, digital health and procurement. The inclusion of provincial or district-level malaria focal points or health officials should be considered, as should additional representatives of ministry of health programmes that are affected by the decisions made for one or several malaria interventions. These include the maternal and child health programme, the Essential Programme on Immunization (EPI), and the neglected tropical diseases programme.
- **Non-health government sectors.** The team should include representatives of other ministries and departments in the government that are relevant to the malaria discussion, such as the ministries of agriculture, infrastructure, education or finance, or the national bureau of statistics. This is to ensure the decisions made for malaria, and the associated impacts, are evaluated through a broader understanding of the country context. This may also provide opportunities for collaboration, identify activities that may affect the fight against malaria, or identify alternative sources of funding that may otherwise not be evident to the NMP.
- **Local malaria expertise and partnerships.** Various representatives of local, regional or global organizations, universities or research institutions with local malaria expertise should be included:
  - malaria epidemiologists and experts in surveillance, monitoring and evaluation, including expertise in surveillance of *PfHRP2/3* deletions, drug resistance and child immunization;
  - entomologists with deep knowledge of local vector species (including invasive species), bionomics and susceptibility to commonly used insecticides, and experience in integrated vector control;
  - health systems experts with a special focus on management of malaria both at tertiary and primary health-care levels;
  - experts in social health determinants with an understanding of community acceptability and use of malaria interventions, preferably including knowledge of the unique health needs within urban ecosystems for efficient tailoring of malaria interventions to microgeographies of transmission;

- health economists familiar with costing and optimization of resources;
- civil society representatives to provide community perspectives as inputs for decision-making; and
- representatives from donors, WHO and other global and regional stakeholders.
- **Data and analysis.** Individuals with data management and analytical skills in statistics and geospatial or mathematical modelling should be included as an integral part of the SNT team. Ideally, one or several locally based analysts should be assigned leading roles in executing the SNT exercise. Where necessary, countries may opt to engage external partners with relevant expertise. Such collaborations should be guided by a clear plan to build inclusive and sustainable local capacity, promote knowledge transfer, and progressively reduce reliance on external support over time.

#### 2.2.1.2 Scope of work, including roles, responsibilities and timelines

The scope of work will be primarily driven by the question at hand and the goal of the SNT process (e.g. malaria programme review, formulation of the NMSP or operational plans, informing delivery of an intervention, assessing the impact of previous interventions).

The scope of work and roles and responsibilities will vary according to country context.

A template terms of reference for the SNT team technical lead is available in Annex 1.

Nevertheless, the main tasks of the SNT team should include the following:

- **Development of a detailed workplan.** The SNT process requires thorough planning, as it involves subnational data analysis, multiple reviews, and stakeholder consultations. A detailed workplan should outline roles and responsibilities, with a timeline of at least 6–12 months, aligning with the malaria planning and implementation cycle. Timelines are proposed alongside each of the 10 implementation steps in this section (and Box 3) and should be aligned with planning cycles as noted in Fig. 5.
- **Regular meetings with an appropriate quorum.** The SNT team will meet regularly to implement the workplan, track progress and address follow-up actions. Attendance will be flexible, with team leaders ensuring the presence of relevant experts as needed.
- **Deciding on the lowest operational unit for decision-making.** This decision will reflect the lowest unit at which specific interventions are feasible. This will determine the granularity required for data collection and analysis.
- **Oversight and management of data and information collection.** This will include: 1) listing the data requirements for the SNT exercise; 2) mapping data sources, particularly important in the absence of a centralized repository; 3) appointing one or more data managers responsible for structuring, cleaning and managing datasets for analysis; and 4) reviewing descriptive outputs from the data management process to assess strengths and limitations, and validate the suitability of each data source for analysis and decision-making.
- **Contributing to and generating outputs for decision-making.** Outputs include descriptive analytics, stratification maps, intervention combination maps, scenario analyses, and modelling results. The SNT team will also contribute to costing the

resulting intervention combinations and scenarios, and participate in optimization efforts once available resources are identified.

- **Working towards consensus on interventions.** The SNT team will present, review and reach consensus on intervention criteria and scenarios of intervention combinations among all relevant stakeholders through an iterative process in which decisions are made and incorporated as the analytical work proceeds.
- **Revising analytical outputs.** The SNT team should revise analytical outputs over the lifespan of the NMSP as resources or new interventions become available or if malaria transmission trends change.
- **Monitoring and evaluation.** The SNT team should monitor and evaluate outcomes and document the process and lessons learned, including the question raised and use cases for SNT, the evidence generated to address these, the use of the evidence , and the impact.

#### 2.2.1.3 Mobilizing resources

Funding needs will vary by country. The following costs should be considered for an analytical exercise such as SNT, whether integrated into an existing national decision-making framework or conducted independently.

- **Organization of meetings.** Meeting costs may include regular reservations of a meeting room with audiovisual infrastructure and the appropriate size to gather the SNT team, present information and connect those who require remote participation. For longer meetings, which may happen less regularly, aspects such as per diems, coffee and lunch breaks, and transportation may need to be considered.
- **Analysis.** Funding for one or several national and external analysts will need to be allocated if the NMP requires such support. As best practice, the budget for analysis of SNT should be part of future monitoring and evaluation components of the NMSP. Where a country relies on external support, such engagements should always embed activities to build the capacity of their local counterparts and over time reduce the need to rely on external funding.
- **Report production, publication and dissemination.** Resources may be required to produce a report of the SNT exercise, especially when countries are interested in producing official reports or publishing peer-reviewed materials. Dissemination and printing costs may also be considered, especially if countries decide to present the report to a wider audience as part of a national event.

#### 2.2.2 Step 2: Data assembly and management

Data-collection efforts over the past decade have resulted in more subnational and disaggregated data in most malaria endemic countries. Countries are increasingly using DHIS2 and similar tools for the routine collection of malaria data through their national HMISs. This enables countries to collect data in a standardized format at all levels of the health system, disaggregate data on critical dimensions such as age, sex and geography (which is essential to uncover hidden inequities), and monitor reporting, completeness

and quality of the information shared. NMP analysis and decision-making can be further supported by integrating data – including qualitative data – from other sources, such as demographic data from national surveys and weather and financial data.

### 2.2.2.1 Identification of data needs

The first step in data assembly and management is to identify what data is needed to address the original goal of the SNT process. This involves developing a data needs checklist (Annex 2), identifying data sources and availability of disaggregated data, and defining operational and temporal units for analysis. While assembling subnational data can be time consuming, the availability of routine HMIS data has improved with the adoption of digital platforms such as DHIS2 and geocoded data for administrative boundaries and health facilities. However, accessing subnational entomological, programmatic, logistic, financial and intervention-efficacy data remains challenging due to fragmentation across partners. Some ecological, climatic and household survey data are available online, but the data are often delayed. More information can be found in Annex 2.

### 2.2.2.2 Review, cleaning and management of data

Datasets must be reviewed, cleaned and managed to ensure the data are suitable for decision-making purposes. This process should consider aspects such as the completeness of the available datasets, and screen for standardized data quality indicators (17, 18) to detect outliers, incoherent information and other problems. Data quality should be assessed for disaggregated data (e.g. by age and sex) which will enable variation between population subgroups to be understood – for example, differences in access or outcomes between men and women, children and adults, Indigenous populations or mobile and migrant populations, all which are often overlooked, but can indicate which groups are being underserved. This is essential to designing equitable intervention targeting.

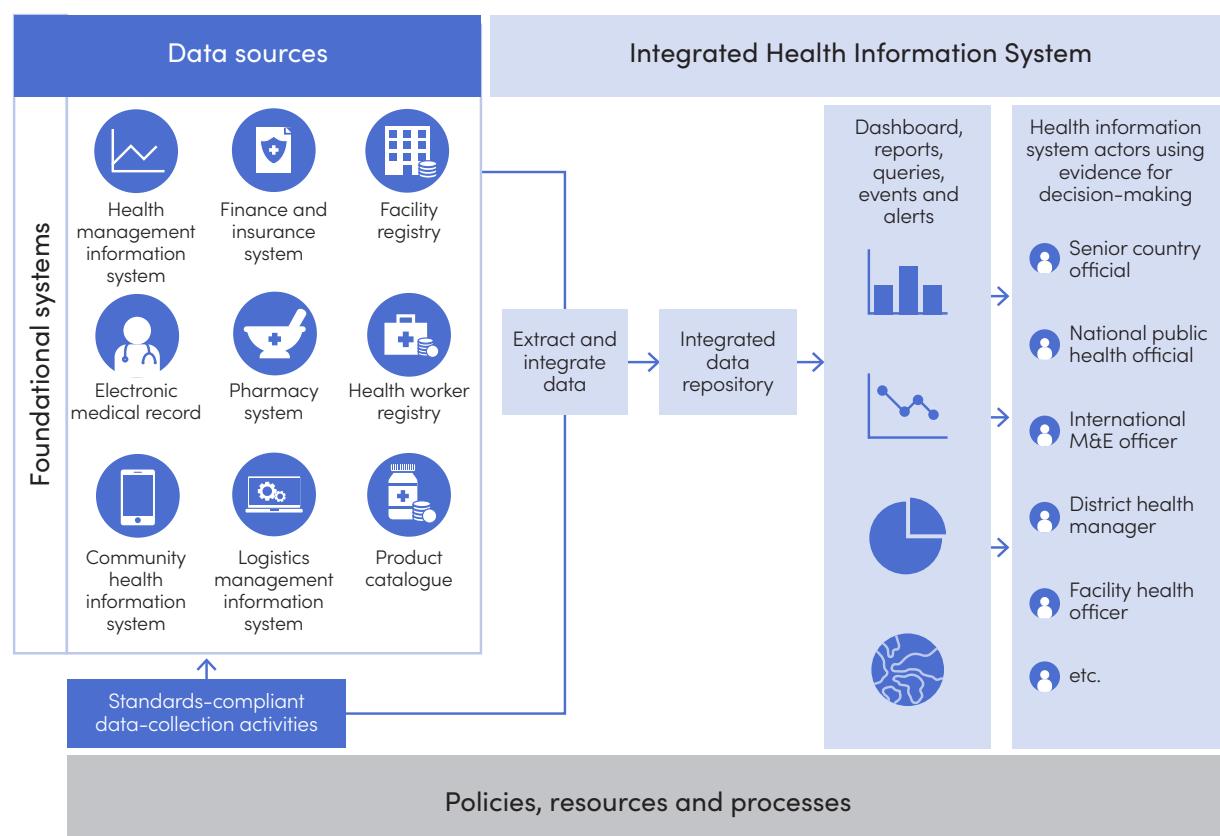
Outputs and insights from routinely conducted data audits and data review meetings and available publications should be used to understand and communicate data limitations. It will also be crucial to link all datasets to their respective geocoded administrative boundaries (shapefiles) at the highest spatial resolution relevant for operations. The following are examples of best practices for data assembly and management:

- Ensure data is accurate and up to date. Data should reflect the current operational units, based on administrative records and linked to shapefiles that define the geographical boundaries of the unit. Datasets should use the most recent, accurate data sources. Local leaders, technical experts and communities should be engaged to verify and validate data. Data managers should be transparent about quality limitations in the data.
- Develop an integrated NMDR (Fig. 6) that serves as a centralized data warehouse or information system with structured national and subnational datasets encompassing all malaria-related data, including epidemiology, entomology, vector control, chemoprevention, finance and contextual data such as population denominators.

- Develop analytical dashboards to visualize NMDR information through indicators and dashboards. NMDRs provide NMPs with a comprehensive view needed to address programmatic questions, monitor progress and implement data-driven interventions.
- Establish clear mechanisms for appropriate data access by all relevant stakeholders, including front-line staff such as community health workers (CHW).

Ideally, countries should establish an NMDR or organize the necessary datasets for decision-making before beginning the analysis for SNT. Where an NMDR is not yet in place, the SNT process should be leveraged to structure and prepare data for integration into an NMDR at the process's completion. The establishment of an NMDR requires working through a series of activities (19). These include setting the foundation with stakeholder collaboration and workplan creation, defining requirements such as listing data elements, mapping current data processes, and planning data integration. The platform is then developed iteratively, followed by training to prepare for its rollout. Finally, system maintenance, including clear governance, monitoring and evaluation, is essential to ensure data quality, proper use and regular updates.

**Fig. 6. WHO-recommended NMDR structure**



Source: WHO (19).

## 2.2.3 Step 3: Situation analyses

This section provides a summary of the general approaches for situation analyses. The WHO manual for malaria programme reviews (10) and the malaria surveillance, monitoring and evaluation reference manual (17) provide additional information.

A situation analysis involves a detailed analysis of the country's malaria national and subnational context, focusing on interventions, progress and challenges. Situation analyses should align with and be embedded in malaria programme review and mid-term review activities. These typically include desk review of strategic documents and data, stakeholder consultations, and field assessments to evaluate programme performance, identify gaps and bottlenecks, and inform strategic decision-making.

The situation analysis, if sufficiently robust subnationally, helps lay the foundations of SNT for NMSP development.

- It will help identify the list of interventions that have been implemented for each operational unit and their estimated impact. Impact should be assessed at a disaggregated level; for example, by examining differences between males and females, supplemented by relevant social factors such as education level and economic status. This could include assessing whether an intervention has greater impact across sex when stratified by wealth quintiles or educational attainment.
- It highlights where impact has been shown (and where it has not – and determines whether this is due to the intervention not working well or due to other factors and why). This includes assessing not only whether interventions themselves are effective, but also whether structural barriers (e.g. limited access to services, socioeconomic inequality, social exclusion) are constraining their reach or effectiveness.
- It signals where and for whom (which subpopulations) intervention coverage needs to be improved, identifies population groups and geographical areas that may require new or adapted interventions, and identifies where existing interventions may be scaled back.

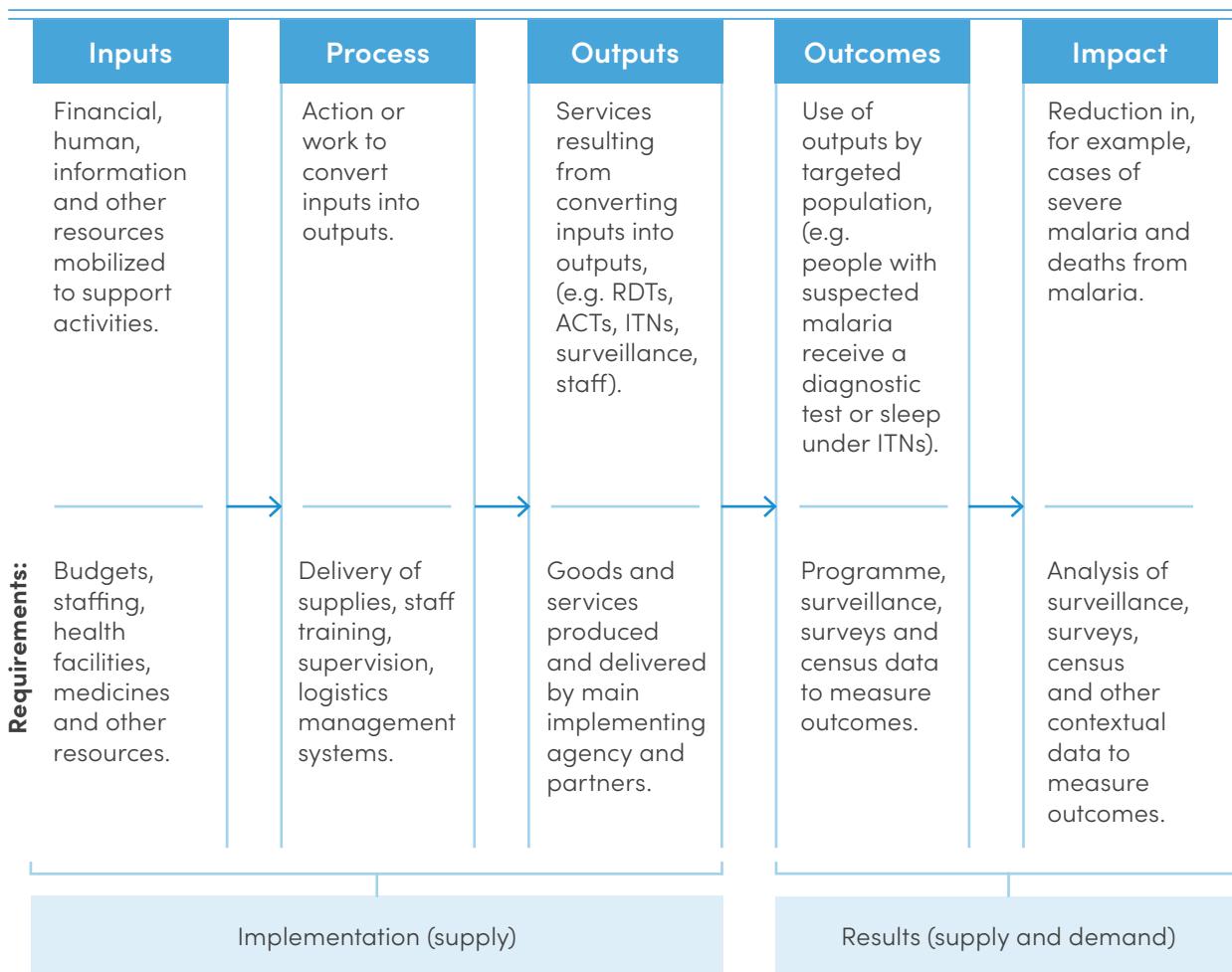
By highlighting inequities in impact and access, the situation analysis enables more equitable, responsive and efficient planning, ensuring that interventions are tailored to include the needs of those most at risk and least reached. Where a formal strengths, weaknesses, opportunities and threats (SWOT) analysis is performed as part of a malaria programme review or mid-term review, relevant findings from it, such as system bottlenecks or implementation opportunities, should be considered when interpreting the feasibility of SNT recommendations.

The situation analysis should ideally build on the data available through the NMDR or compiled at the onset of the SNT exercise. Countries may also choose to undertake operational research or targeted data-collection activities for information that is not readily available. Such activities usually involve visits to districts, health facilities or communities and can be done by leveraging existing operational activities, such as health facilities supervision.

The primary indicators used in a subnational review relate to malaria inputs (health and malaria expenditure), processes (planning and training), outputs (intervention distribution and health-care access) and outcomes (intervention coverage and usage). The review

also considers external factors that influence impact (climatic or environmental elements, population movement, conflict, poverty and education, etc.). These indicators are then contrasted against impact indicators on malaria burden, morbidity and mortality (Fig. 7). Indicators should be disaggregated (e.g. by age and sex) and supplemented with qualitative data (where available) to ensure potential inequities are captured.

**Fig. 7. Monitoring and evaluation framework: from inputs to impact**



ACT: artemisinin-based combination therapy; ITN: insecticide-treated net; RDT: rapid diagnostic test.

Source: WHO (17).

The situation analysis uses two approaches for analysis.

- Subnational descriptive analysis is used to understand spatio-temporal and population-level patterns and trends in:
  - health and malaria expenditure and health system status, with a focus on health-care availability, accessibility and quality;
  - malaria intervention distribution, coverage and use, disaggregated by age, sex, geography and other relevant social dimensions;
  - other determinants of progress in malaria morbidity and mortality, such as biological, climatic, environmental and humanitarian threats; and
  - key epidemiological impact indicators.

- Subnational analysis of the association between intervention distribution (timeliness and efficiency), coverage, use and other determinants and the patterns and trends in primary malaria outcomes should be used to explore whether certain population groups (e.g. children, women, occupational groups or Indigenous populations) face greater barriers to diagnosis and treatment or intervention reach and experience differential outcomes as a result.

Qualitative contextual information, including systemic, governance, political and cultural factors, should also be analysed to inform the implementation of malaria elimination and control as well as the measured outcomes and impact. This includes governance structures, resource allocation, local decision-making power and gender norms.

The analyses performed for the situation analysis should be done at the lowest administrative level used for operational planning. This is usually the district level. Countries that plan at a regional (or provincial) level should consider expanding their understanding to a more granular level to accurately guide their malaria control and elimination strategies. Situation analyses should evaluate a reasonable period that covers at least 3–5 years to allow changes over time to become evident in the data.

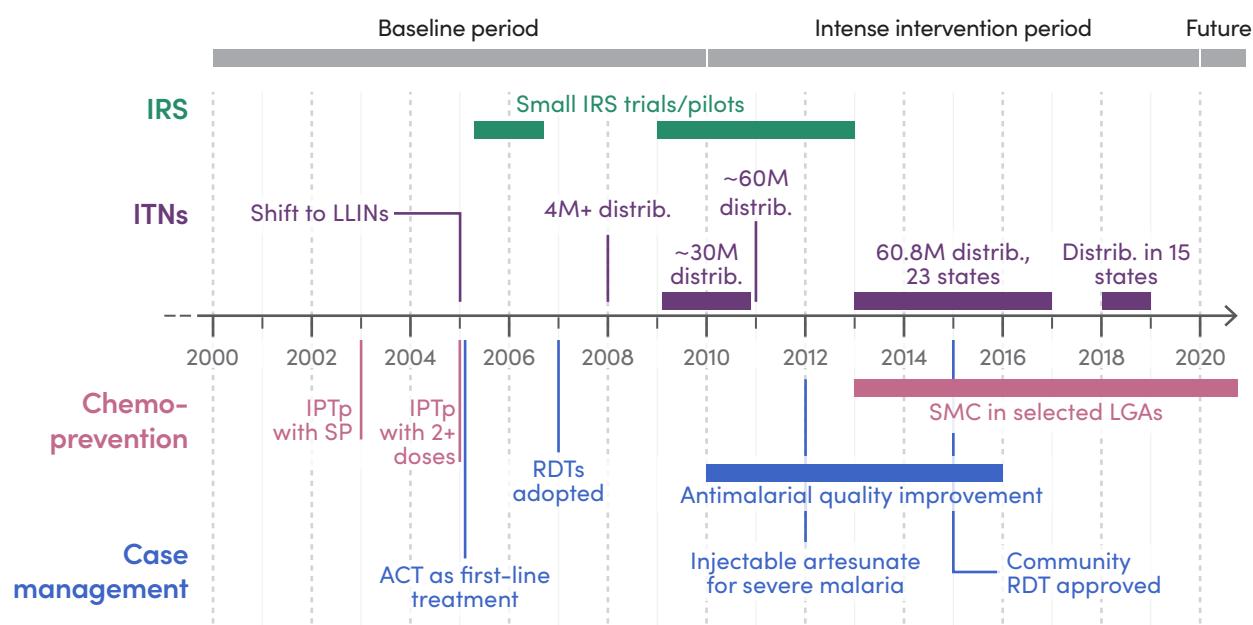
### 2.2.3.1 Subnational descriptive analysis

To perform a subnational descriptive analysis, first subnational level activities and timelines should be depicted, outlining the implementation of malaria control activities, household surveys, changes in national and global policies, and donor funding (see the example in Fig. 8). This timeline can be presented at district level, regional level or for each epidemiological stratum, and may include several indicator trends for the same district/region/stratum in a single graph to compare trends or identify anomalies or inconsistencies in the data. Alternatively, graphs may include the same indicators from different districts/regions/strata to visualize differences in magnitude. Maps representing the information of a specific indicator per district-year may also be used to visualize the spatio-temporal variations of a specific indicator.

Second, a comprehensive description of the malaria situation and its determinants is essential. Descriptive analyses (Fig. 9 and Fig. 10) involve summarizing and interpreting data, including:

- distribution – patterns of values, such as case counts over time or the percentage of cases among men versus women;
- quantity – a breakdown of cases by categories, such as age groups;
- quality – an assessment of missing data, errors and outliers; and
- contextual factors – potential biases, data-collection methods and dates of collection.

**Fig. 8.** A timeline of the principal malaria control activities deployed in Nigeria between 2000 and 2020



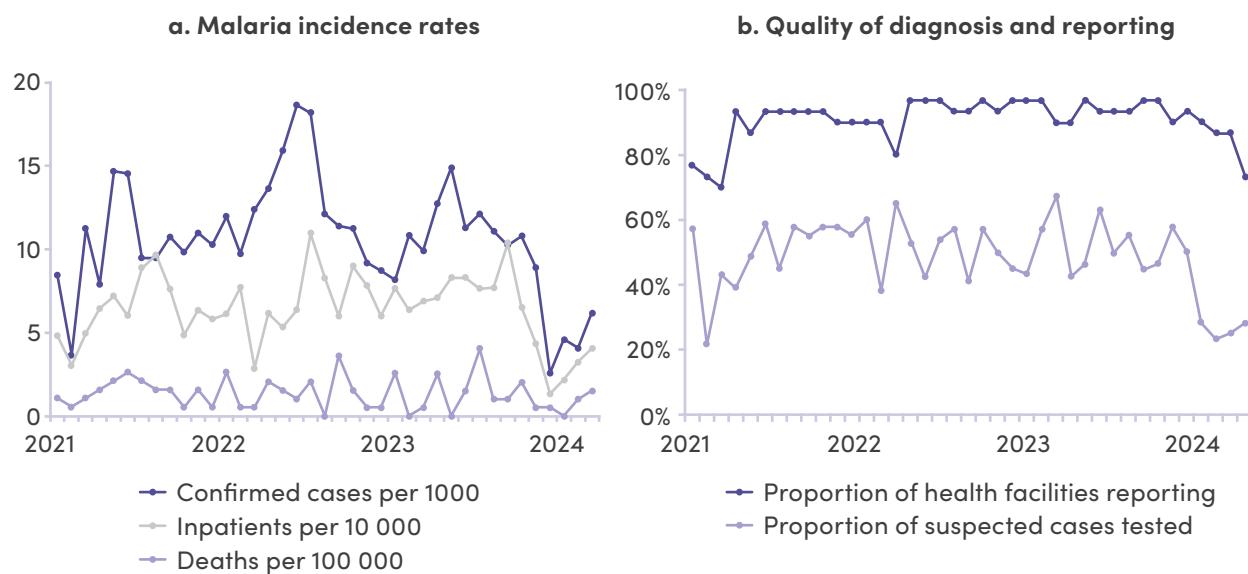
ACT: artemisinin-based combination therapy; IPTp: intermittent preventive treatment in pregnancy; ITNs: insecticide-treated nets; IRS: indoor residual spraying; LGAs: local government areas; RDT: rapid diagnostic test; SMC: seasonal malaria chemoprevention; SP: sulfadoxine pyrimethamine.

Source: Adapted from Ozodiegwu et al. (20).

Malaria outcome metrics, such as reported incidence, should be analysed across time, location and different population groups (including age and sex) (Fig. 9a). Additionally, factors influencing these outcomes must be considered, including interventions (e.g. vector control coverage), environmental variables (e.g. temperature or rainfall), treatment availability and health-care access.

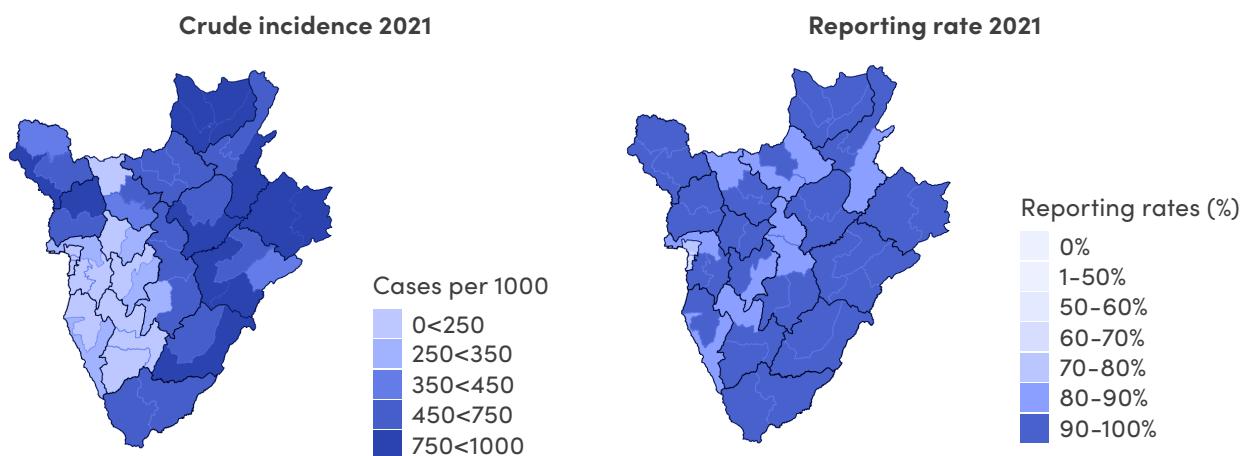
The number of observed malaria infections depends on surveillance capacity – how many people are tested and the completeness of reporting (Fig. 9b). Each of these factors should be examined individually and collectively to generate hypotheses about the underlying drivers of malaria patterns (21). The WHO Academy course “Malaria: harnessing the power of routine health facility data”, while primarily designed for subnational staff analysing routinely reported data, provides guidance on conducting and interpreting descriptive analyses to monitor trends in cases and routinely implemented interventions (22).

**Fig. 9.** Charts for analysis of malaria trends in a) malaria incidence and b) testing and reporting



Source: (18).

**Fig. 10.** Extract of maps produced in 2022 for the subnational estimation of malaria incidence in Burundi using routine data from 2021, including reporting rates



Note: The administrative units shown on these maps correspond to the administrative divisions in effect prior to the change that took place on 1 July 2025, in Burundi

Source: (17).

After an initial descriptive analysis of key malaria metrics, high-quality and reliable data can be used to assess any statistically significant trends and evaluate progress following interventions. Statistical trends can be analysed using chi-squared or t-tests, or advanced methods such as seasonal decomposition and regression models (linear, Poisson, autoregressive integrated moving average [ARIMA]) depending on methodological applicability (described further in later sections). Simple regression models can also be used to track changes over time but may be influenced by external factors, so comparisons with control groups and adjustments for confounding variables are necessary for accurate interpretation. Other methods include before-after comparisons which measure changes in key indicators by comparing baseline values with postintervention data, using statistical tests to determine significance. Assumptions

made during the descriptive analysis stage should be documented. A well-defined baseline is essential for an accurate assessment of impact (Table 2).

**Table 2. Example of a before–after analysis to descriptively monitor the impact of a combination of interventions (case management, vector control, chemoprevention) in the district of Magude, southern Mozambique**

Indicator	Age group	Phase I		
		August 2015 to June 2017		
		Baseline <sup>a</sup>	Endpoint <sup>b</sup>	Percentage reduction
<b>Infection prevalence by microscopy</b>	< 6 months	4.2 (1.8 – 8.1)	0 (0, 5.7)	100
	6 months – 2 years	5.1 (2.5 – 9.1)	0.5 (0.2 – 1.4)	89.3 (93.9 – 84.7)
	2 – < 5 years	8.8 (5.4 – 13.5)	2.9 (2.0 – 4.0)	67.2 (62.4 – 70.2)
	5 – < 15 years	10.4 (6.6 – 15.5)	1.6 (0.9 – 2.6)	84.5 (86.0 – 83.2)
	≥ 15 years	5.4 (2.6 – 9.7)	0.3 (0.0 – 1.2)	93.7 (98.5 – 87.5)
	<b>All ages</b>	<b>7.1 (5.2 – 9.6)</b>	<b>0.8 (0.5 – 1.2)</b>	<b>89.3 (90.8 – 87.6)</b>
<b>Infection prevalence by RDT</b>	< 6 months	4.6 (2.1 – 8.5)	0	100
	6 months – 2 years	4.6 (2.1 – 8.5)	1.4 (0.7 – 2.4)	70.6 (68.4 – 71.9)
	2 – < 5 years	12.8 (8.7 – 18.0)	0.9 (0.5 – 1.7)	92.8 (94.8 – 90.6)
	5 – < 15 years	14.2 (9.7 – 19.8)	4.6 (3.4 – 6.0)	67.7 (64.6 – 69.7)
	≥ 15 years	6.3 (3.3 – 10.8)	1.8 (0.9 – 3.1)	71.5 (71.9 – 70.9)
	<b>All ages</b>	<b>9.1 (7.0 – 11.8)</b>	<b>2.6 (2.0 – 3.4)</b>	<b>71.3 (71.1 – 71.4)</b>
<b>Malaria case incidence</b>	< 5 years	298 per 1000	83 per 1000	72.1
	≥ 5 years	58 per 1000	16 per 1000	72.4
	<b>All ages</b>	<b>195 per 1000</b>	<b>75 per 1000</b>	<b>61.5</b>
<b>Estimated percentage of cases averted</b>	<b>All ages</b>			<b>75.6</b>

RDT: rapid diagnostic test.

Notes: a. May 2015 for prevalence, and the transmission year of July 2015 to June 2015 for incidence. b. May 2017 for prevalence, and the transmission year of July 2016 to June 2017 for incidence.

Source: Galatas et al. (23).

### 2.2.3.2 Subnational analysis of the association between malaria outcomes and intervention distribution, coverage, use and other determinants

The impact of malaria interventions on malaria epidemiology (trends in malaria case incidence, parasite prevalence, age and sex distributions of uncomplicated or severe malaria burden, etc.) is determined by the following key factors:

- **type of intervention and setting** – for example, the effect of ITNs and IRS will be greater where the dominant malaria vector(s) is night- and indoor-biting and indoor-resting than in places where outdoor-biting and outdoor-resting vectors predominate;
- **fraction of the at-risk population that can be protected by effective control measures** – the greater the fraction that is protected (or covered), the larger the reduction that can be expected;

- **pre-control baseline** – in general, the higher the malaria baseline in an area, the greater the fraction of the at-risk population that must be protected with control interventions to achieve a reduction in transmission to a lower level;
- **entomology** – vector species, their abundance and behaviour, biting rates, and resistance to insecticide;
- **health system readiness** – accessibility, timeliness, intensity and quality of service delivery, quality of surveillance systems and data;
- **human behaviour** – use of interventions and other behaviour related to risk of exposure, access and adherence to treatment;
- **ecology** – climatic factors (altitude, temperature, rainfall), environmental factors (vegetation, agriculture, housing, urbanization, infrastructure, etc.); and
- **other contextual and programmatic factors** – socioeconomic status, occupation, conflicts, location of refugees and internally displaced persons or other humanitarian emergencies and resources.

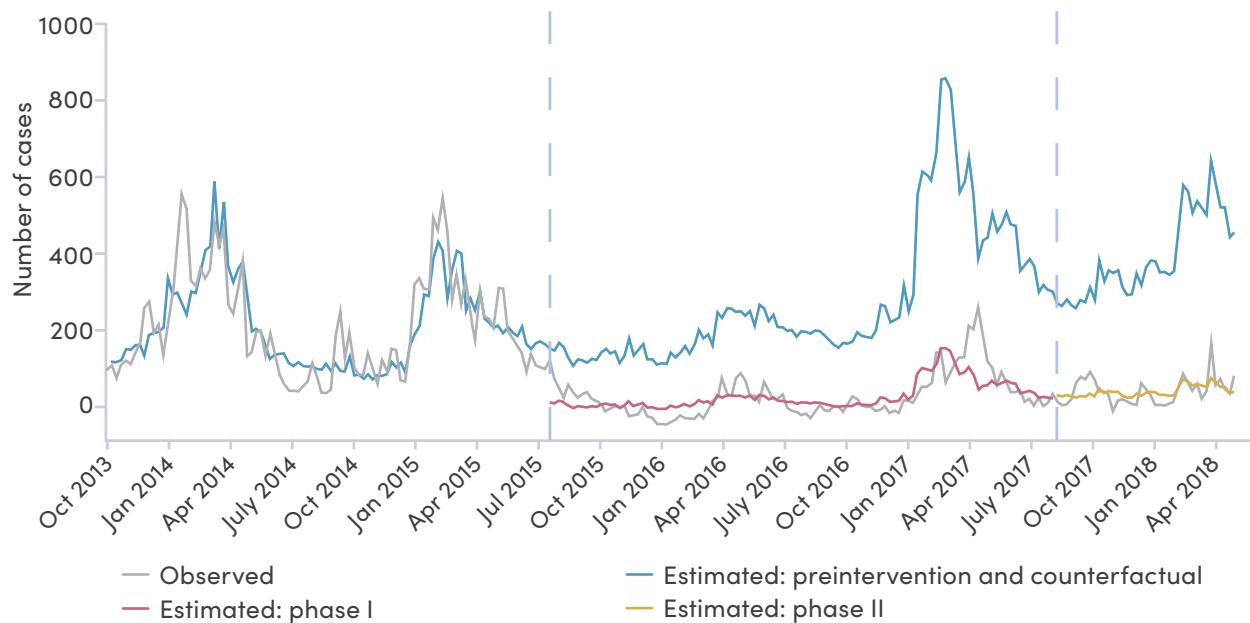
The factors listed above have different levels of association and relevance depending on the impact indicator being evaluated. For example, interventions aiming to prevent the progression from uncomplicated to severe malaria will have a larger impact on the number of malaria admissions than on parasite prevalence or incidence. Given that progress reviews rely on programmatic data for impact evaluation (and do not use clinical trial data to evaluate the impact of a specific intervention) it is important that “plausibility arguments” are developed to evaluate the impact of different interventions on specific malaria outcomes. This entails hypothesizing causal pathways explaining the changes in particular malaria outcomes. The plausibility of the hypothesis that changes in malaria impact indicators reflect mainly programmatic efforts will be evaluated, controlling for additional factors external to malaria programmes.

Several analytical approaches are commonly used to measure the impact of specific interventions on malaria epidemiology while controlling for the effect of all additional potential factors described above.

- **Subnational dose-response analysis** uses appropriate regression approaches to assess the association between intervention coverage or usage indicators and malaria epidemiological outcomes. These may include count models such as Poisson or negative binomial regression, which can be adapted for time-series data, as well as classical time-series models such as ARIMA.
- **Interrupted time series analysis** estimates the effect of an intervention (interruption) by comparing the immediate change after the intervention and the average trend in a specific malaria outcome indicator over the analysis period, before and after the intervention was introduced. It also uses preintervention relationships between the outcome (dependent variable) and relevant predictors (independent variables) to project what the outcome would have been if the intervention had not occurred. This is known as the “counterfactual”. For example, if case incidence dropped following a new vector control intervention or combination of interventions (Fig. 11), the model estimates how incidence would have evolved in the absence of that intervention or combination of interventions, based on historical trends and covariates (24). To apply this method robustly, outcome and covariate data from at least 2 years before the intervention are required.

- **Mathematical modelling** can be useful to complement other analyses to assess and simulate the impact, from baseline up to the current time, of the scale-up of interventions. Mathematical models provide the appropriate flexibility to implement such analyses, comparing to counterfactual, but should as much as possible be parameterized and validated based on available high-quality local data. (See more details on the use of mathematical models in Annex 7.)

**Fig. 11.** Example of an interrupted time series analysis to evaluate the impact of a combination of interventions in Magude district, southern Mozambique, on the weekly number of malaria cases in the period immediately following the implementation of phase I (August 2015) and phase II interventions (September 2017)



Source: Galatas et al. (23).

The situation analysis, which assesses the impact of previous activities and interventions and measures progress – or lack thereof – on epidemiological, entomological, health system and other indicators, along with their drivers, will inform the development of summary recommendations for intervention selection and implementation. This review should be part of mid-term or end-term malaria programme evaluations.

## 2.2.4 Step 4: Stratification of malaria risk and its determinants

A country should follow several steps to design a set of intervention combinations tailored to the local context, including:

- **listing all potential interventions** and strategies, reviewing WHO intervention recommendations (3) to establish context-specific criteria and thresholds for deployment;
- **stratifying** malaria risk (epidemiological factors) and its determinants (interventions, demographics, ecological factors) at the relevant subnational level based on the defined criteria and thresholds; and
- **tailoring individual interventions and their combinations** to align with the stratified malaria risk and its determinants.

The first of these are discussed below and the third is discussed in section 2.2.5.

### 2.2.4.1 List interventions for considerations and define criteria for tailoring

Each country has a set of interventions implemented under a previous NMSP. These interventions may align fully with WHO recommendations or be adapted to the local context. Following a situation analysis, a country may choose to introduce new interventions or discontinue existing ones. Countries should develop a list of interventions and strategies for consideration. It is also essential to incorporate broader malaria control and elimination requirements, such as surveillance, monitoring, evaluation, supervision, training, quality-of-care improvements and operational research.

While resource availability is a key consideration throughout, the initial stages should focus on identifying what needs to be done, where and when (i.e. interventions tailoring). Prioritization and resource optimization should be addressed in later stages.

However, countries should avoid spending excessive time on interventions that are clearly unsuitable for the local context or financially unfeasible within the NMSP's time frame.

**Once all interventions and strategies of interest have been identified**, intervention-specific criteria are defined by the WHO recommendation and adapted to local context (2). It is important that countries understand the WHO recommendations are not designed to be prescriptive but to provide the evidence base to support policy-making by countries (Table 3).

**Table 3. Illustrative example of potential targeting criteria to be adapted to country context for a set of WHO-recommended interventions (the NMP may decide to use all, some or other criteria).**

Intervention	Transmission (incidence, prevalence, mortality, etc.)	Age distribution of burden	Seasonality	Entomo- logical indicators	Environment and urbanicity	Vulnerable populations, conflict, emergencies
ITNs	+			+	+	+
IRS	+		+	+		
LSM	+			+	+	
SMC	+	+	+			
MDA	+	+				+
IPTp	+					
PMC	+	+	+			
Vaccination	+	+	+			+
iCCM	+					+
Surveillance	+	+				

iCCM: integrated community case management; IPTp: intermittent preventive treatment in pregnancy; IRS: indoor residual spraying; ITN: insecticide-treated net; LSM: larval source management; MDA: mass drug administration; PMC: perennial malaria chemoprevention; SMC: seasonal malaria chemoprevention.

Note: plus signs (+) in the table identify the information (columns) that will inform the targeting criteria per intervention (rows).

## 2.2.4.2 Stratifying malaria risk and its determinants

Malaria stratification has long been used in planning malaria programmes. Ecological and climatic suitability maps, combined with targeted malaria metrics surveys, were used during the Global Malaria Eradication Programme in the 1950s and 1960s and most of the first decade of this millennium (25–27). Over the past decade, empirical maps of malaria risk, informed by community prevalence data modelled using geospatial techniques, have become the standard for malaria risk mapping in moderate and high transmission settings. With the rapidly expanded use of rapid diagnostic tests in malaria case management in the health system and use of digital solutions to strengthen surveillance systems, routine case-based data are increasingly used by countries for malaria risk stratification (28–31).

Stratification involves classifying geographical areas based on epidemiological, ecological, social and economic factors to guide malaria interventions. Since no two areas share identical risk levels, intervention coverage or contextual constraints, stratification enables a tailored approach and can include *risk stratification* (i.e. classification of geographical areas or localities according to factors that determine receptivity and vulnerability to malaria transmission) and/or *interventions stratification* based on eligibility and other criteria (e.g. endemicity criteria). Stratification uses a multimetric framework, factoring in baseline and current endemicity, temporal trends, intervention impact and local determinants to categorize areas into transmission risk levels (e.g. low, moderate, high) using indicators such as prevalence and incidence. Advanced statistical and geospatial methods generate composite risk maps, integrating data on entomology, ecology, human behaviour, health system capacity and socioeconomic conditions. These maps are validated by local experts to account for data limitations and ensure context-specific accuracy, thereby supporting more effective and targeted malaria control and elimination strategies.

It is important to distinguish between simply mapping the spatial distribution of an indicator and stratifying it based on the specific question at hand. Stratification involves transforming an indicator into meaningful categories that align with decision-making needs in malaria response for each setting. These categories must be strategically relevant for effective subnational planning. For example, converting a malaria risk map into categories based on the malaria transmission continuum (see section 1.3.1 and Annex 3) to guide intervention strategies would be considered malaria risk stratification. Similarly, categorizing malaria seasonality into areas suitable for SMC constitutes seasonality stratification. However, seasonality can also be stratified for other purposes, such as identifying areas at high risk for epidemics, which may require a different classification despite using similar seasonality data.

To provide the information needed for programmatic use, the stratification analysis should be done at the subnational unit of operation or lower levels. In settings with high transmission, the NMP usually stratifies subnational areas such as districts, health zones, provinces or regions. As countries progress towards elimination, finer scale mapping is required, and stratification should be more specific, ideally at the level of localities or health facility catchment areas, usually using absolute case data (17). As such, the process of stratification requires the following steps.

- Define the spatial units at which operational decision-making can be made (which could consist of regions, districts, health facilities catchment areas, villages or communities).
- Generate the set of data for each spatial unit necessary to stratify them. Combining routine data and surveys provides a comprehensive view of malaria transmission, though addressing gaps and inconsistencies is essential. This process may either rely on actual data, or modelling to estimate the distribution of the indicator (Table 4).

Identify the criteria and threshold for stratifying an indicator, which will likely vary depending on the issue under discussion. Indicators may also be stratified in time, in different risk populations and demographics (e.g. age, sex, occupation).

**Table 4. Summary of priority indicators considered for stratification for SNT (a complete list of variables is provided in Annex 5)**

Category	Priority indicators	Example data sources
<b>Epidemiological</b>	Parasite prevalence	Household surveys and or spatial-temporal estimates (e.g. prevalence maps from Malaria Atlas Project (32)) Antenatal care registers (33)
	Uncomplicated and severe (total) malaria cases	Routine outpatient and inpatient data
	Case incidence/annual malaria incidence	Routine outpatient and inpatient data (population data from national population census)
	Malaria and all-cause under-five mortality rate	Routine outpatient and inpatient data
	Parasite species distribution	Routine outpatient and inpatient data
	All-cause and malaria inpatient admissions	Routine outpatient and inpatient data
	Predischarge mortality fraction	Routine outpatient and inpatient data (can be supplemented with mortality data from vital registration)
<b>Entomological</b>	In elimination settings: number of confirmed cases, their distribution and classification (locally acquired or imported)	Routine surveillance data (e.g. case notification and case investigation forms)
	Mosquito vector species	Entomological surveillance
<b>Interventions</b>	Mosquito behaviour (resting and biting)	Entomological surveillance
	Types	NMSPs
	Distribution	Routine outpatient and inpatient data Household surveys
	Coverage	Routine outpatient and inpatient data Household surveys
	Efficacy	Efficacy studies (e.g. therapeutic efficacy studies for treatment, research studies) (34)
	Resistance	Molecular surveillance, research studies

Category	Priority indicators	Example data sources
<b>Health system readiness</b>	Accessibility	Surveillance assessment reports
	Timeliness	Data quality/surveillance assessment reports
	Quality of service delivery	Routine surveillance data for commodity stock outs, quality-of-care information/surveys (e.g. research studies, service availability and readiness assessment (35), and government health infrastructure records)
	Surveillance system coverage, completeness, timeliness, quality, access and use of data	Data quality/surveillance assessment reports
<b>Ecological</b>	Climatic factors such as altitude, temperature, rainfall, seasonality	Meteorological data from weather stations, satellite imagery
	Environmental factors such as vegetation, agriculture, housing, urbanization, infrastructure	Environmental data from relevant government departments/institutions, satellite imagery
<b>Human behaviour</b>	Use of interventions	Household surveys, research studies
	Mobility and migration	National population census, mobility studies, departments of immigration and transport
	Other behaviour related to risk of exposure and access to care (e.g. forest goers)	Special population surveys and epidemiology studies
<b>Other contextual factors</b>	Population denominators	National population census
	Socioeconomic status	Household surveys
	Occupation	Routine outpatient and inpatient data Household surveys
	Conflicts or other humanitarian emergencies	Refugee and population displacement records (e.g. from OCHA)
	Location of refugees and internally displaced persons	Refugee and population displacement records (e.g. OCHA)

NMSP: national malaria strategic plan; OCHA: United Nations Office for the Coordination of Humanitarian Affairs

The stratification process is iterative, requiring periodic refinement based on updated data and the observed impact of interventions. This ensures stratification remains a dynamic tool for guiding operational decisions and resource allocation, ultimately improving the effectiveness of malaria control programmes at the subnational level. More information on stratification can be found in Annex 5, and an example of how to stratify (for an illustrative country) can be found in section 2.3.1.

## 2.2.5 Step 5: Intervention tailoring and prioritization

The ultimate aim of the SNT process is to provide countries with the best possible combinations of interventions and strategies to achieve their goal and to guide subsequent optimization of resources. To do this, each intervention and strategy must first be tailored separately to each operational unit before choices are eventually made between interventions for that unit. By providing guidance on aligning strategies with epidemiological and operational realities, this section equips implementers with the tools needed to maximize the effectiveness of malaria control efforts, while ensuring resources are used efficiently and equitably.

Implementation of the SNT process requires a thorough understanding of the WHO malaria recommendations and advice related to their practical application. Countries are advised to refer to the consolidated WHO guidelines for malaria (2) for detailed recommendations and nuance on the use of malaria interventions and strategies. Additional WHO implementation and operational manuals that provide additional practical guidance are cited throughout this section. WHO has also published guidance on decisions to help prioritize key interventions (3).

Information provided in this manual supports use of WHO guidance and practical advice on the WHO recommendations to develop context-specific criteria for local deployment and prioritization using the SNT process. Table 5 provides an overview of practical considerations, linking the WHO recommendations to criteria for tailoring and intervention prioritization, including:

- guidance for deploying specific interventions (including case management, vector control, chemoprevention and vaccination interventions);
- suggestions for tailoring interventions based on local context; and
- practical considerations for prioritizing interventions tailored to the subnational level.

Refer to Annex 6, the WHO guidelines for malaria (2) and the WHO principles for prioritization (3) for additional information on WHO recommendations for interventions.

**Table 5. Summary of practical considerations for deploying, tailoring and prioritizing malaria interventions and strategies**

Key considerations	Considerations for tailoring	Considerations for prioritization
<b>Case management</b>		
Prompt, accurate diagnosis and effective treatment (species-specific) should be provided for all malaria cases (36, 37), including care at the community level and appropriate management for severe malaria.	Improving malaria case management requires expanding its access (e.g. through new PHC services such as CHWs). New PHC services should ensure consistent commodity supply, enhancing care quality and engaging the private sector and special population groups to broaden reach and effectiveness.	<p>Existing levels of routine case management should not be scaled back and should leverage the broader health system. However, prioritization may weigh up:</p> <ul style="list-style-type: none"> <li>• expanding access versus improving quality</li> <li>• implementing universal treatment versus targeted prereferral treatment</li> <li>• phased implementation versus targeted rollout of G6PD testing and anti-relapse therapy for <i>P. vivax</i>;</li> <li>• private-sector subsidies versus strengthening public sector quality care; and</li> <li>• outreach to mobile populations versus enhancing facility-based case management.</li> </ul>
<b>Vector control</b>		
<b>Insecticide-treated nets (ITNs)</b>		
Selection of ITN type(s) should be based on local insecticide resistance profiles and placement and use should be aligned to vector-biting patterns (e.g. night use) (38). Distribution should be continuous through ANC/EPI and supported by periodic mass campaigns. Digital tools should be used during distribution to support implementation and monitor impact.	<p>ITNs are recommended at all levels of malaria transmission, though their effectiveness depends on transmission intensity. A <math>PfPR_{2-10}</math> threshold of &gt;1% is a useful operational marker for identifying areas for distribution.</p> <p>In elimination or emergency settings, ITNs may be targeted to high-risk groups regardless of transmission thresholds.</p> <p>In urban areas, improved infrastructure and housing can alter receptivity (39), leading to clustered transmission; microstratification should guide targeted ITN distribution where appropriate and acceptable.</p>	<p>ITNs can be prioritized based on level of transmission and targets underserved communities. Next-generation ITNs that are more effective in resistance settings should target the highest burden zones, using resistance data where possible.</p> <p>Urban microstratification can help identify high-risk, low-income areas.</p> <p>Displaced and vulnerable groups should be prioritized even in low transmission settings due to elevated risk and potential for onward transmission.</p>

Key considerations	Considerations for tailoring	Considerations for prioritization
<b>Indoor residual spraying (IRS)</b>		
<p>IRS should be used where vector behaviour, housing and transmission patterns allow for effective protection with 1–2 rounds per year (40).</p> <p>Insecticide selection must be based on local resistance profiles, safety and affordability.</p> <p>Community acceptance is essential due to the need for home access and temporary disruption.</p> <p>Programmes should prioritize high coverage of either IRS or ITNs, as co-deployment offers limited added value. Rotating insecticides supports resistance management and is more easily achieved with IRS.</p>	<p>Operational feasibility and infrastructure support are key, favouring areas with good logistics such as storage facilities and road access.</p>	<p>As with all community interventions, programmes should assess community acceptance, potential impact, and the effectiveness of alternative interventions. This may be more relevant in urban areas where IRS is operationally complex, and alternative interventions such as LSM and housing improvement may be considered.</p> <p>In rural areas, IRS deployment should be based on a comparative analysis of its impact and cost-effectiveness versus high ITN coverage.</p>
<b>Larval source management (LSM)</b>		
<p>Larviciding is suitable where mosquito breeding habitats are few, fixed and easily located, typically in urban or arid areas with stable, clustered sites.</p> <p>Effective implementation requires geospatial and entomological capacity to identify and map these habitats (41).</p>	<p>Larviciding should target low transmission areas with identifiable hotspots, such as in urban settings. It requires recent data on larval habitats near these clusters.</p> <p>Delivery strategies should consider capacity, including innovations, to implement and monitor coverage, quality, and impact.</p>	<p>Integrating larviciding for malaria with existing efforts targeting other vector-borne diseases such as dengue and Zika virus in urban areas can reduce costs.</p> <p>Community participation can further lower costs and support both habitat surveillance and larviciding.</p>
<b>Chemoprevention<sup>a</sup></b>		
<b>Intermittent preventive treatment in pregnancy (IPTp)</b>		
<p>IPTp should be provided to all pregnant women in endemic areas at regular intervals using SP, with doses given at least 1 month apart and aiming for three or more doses.</p> <p>Delivery should occur through ANC, supplemented by community distribution to reach women with limited access to health facilities (42).</p>	<p>Outreach delivery of IPTp, such as through CHWs, can boost coverage while supporting continued ANC attendance.</p> <p>Delivery strategies should consider user preferences, costs, coverage and the sustainability of PHC services.</p>	<p>Existing delivery platforms and outreach activities should be leveraged to sustain ANC and community-based IPTp services.</p>

Key considerations	Considerations for tailoring	Considerations for prioritization
<b>Perennial malaria chemoprevention (PMC)</b>		
<p>PMC should target children at risk of severe malaria in moderate to high, year-round transmission areas.</p>	<p>The EPI platform remains central to delivering PMC, though alternative delivery methods may improve access and integration with other health services.</p>	<p>PMC should be scaled up gradually where expansion is planned, using existing delivery platforms and outreach to sustain services.</p>
<p>Schedules should be adapted to age-specific risk, drug protection duration, feasibility, and cost, using SP or ACTs.</p>	<p>Delivery strategies should consider user preferences, costs, coverage and the sustainability of PHC services.</p>	<p>In urban or well-served areas with strong case management and community referral systems, scaling back PMC may be appropriate.</p>
<p>Note: while previously focused on infants, the intervention now includes children aged 12–24 months (43).</p>		
<b>Seasonal malaria chemoprevention (SMC)</b>		
<p>In areas of seasonal malaria transmission, children belonging to age groups at high risk of severe malaria should be given antimalarial medicines (SP+AQ) during peak malaria transmission seasons to reduce disease burden, with a monthly cycle.</p>	<p>SMC planning should include defining eligible areas based on seasonality and transmission, identifying target age groups using age-specific severe disease data (including above 5 years), and ensuring logistic capacity aligns with deployment requirements.</p>	<p>SMC expansion if under consideration should follow a phased approach.</p>
<p>Adherence should be supported through caregiver counselling and community engagement (44).</p>		<p>Reassess demographics and geographical eligibility criteria based on evidence.</p>
<p>Children who are ill should be tested for malaria, and if positive should receive treatment.</p>		<p>Programmes may choose to continue targeting children under 5 years of age despite shifting disease patterns or updated seasonality analyses.</p>
<p>Programmes should establish pharmacovigilance systems, monitor drug resistance, and track malaria cases and deaths (45).</p>		<p>Adjustments may include scaling back in urban or well-served areas, or reducing the number of monthly cycles (e.g. from five to four) where appropriate.</p>

Key considerations	Considerations for tailoring	Considerations for prioritization
<p><b>Vaccines</b></p> <p>Malaria vaccination is recommended for children living in moderate to high transmission areas and may be considered in low transmission settings based on national priorities, feasibility and cost-effectiveness (46, 47). NMPs and national immunization programmes should collaborate closely when planning malaria vaccine introduction (48). The NMP defines the subnational areas that would benefit from malaria vaccine introduction and recommends the delivery approach, while the national immunization programme leads malaria vaccine planning and delivery.</p> <p>Malaria vaccination should be integrated into national malaria and immunization plans and can be combined with PMC or, in highly seasonal areas, be provided pre-seasonally before SMC.</p> <p>Adverse events should be documented.</p> <p>Malaria vaccines should be provided in a four-dose schedule in children from 5 months of age for the reduction of malaria disease and burden.</p> <p>A fifth dose may be given 1 year after the fourth in areas of highly seasonal transmission or where malaria risk remains high during the third year of life and beyond.</p>	<p>In areas of highly seasonal transmission, a seasonal or hybrid delivery approach may be used for increased vaccine protective efficacy.</p> <p>A fifth dose can be considered where the risk of severe malaria and mortality persists into the third year of life.</p>	<p>Areas of moderate and high transmission should be prioritized.</p> <p>Considerations for further prioritization could include malaria burden and epidemiology (including severe malaria and/or mortality), overall malaria control strategy, and the ability to achieve high uptake, acceptability and equity.</p>

ACT: artemisinin-based combination therapy; ANC: antenatal care; AQ: amodiaquine; CHW: community health worker; DOT: directly observed therapy; EPI: Essential Programme on Immunization; G6PD: glucose-6-phosphate dehydrogenase; PfPR: *Plasmodium falciparum* prevalence rate; PHC: primary health care; SP: sulfadoxine pyrimethamine

Note: <sup>a</sup> Chemoprevention includes other interventions not referenced in the table; for example, mass drug administration (MDA), post-discharge malaria chemoprevention (PDMC), and intermittent preventive treatment in school-aged children (IPTsc), which can play a critical role in reducing malaria burden in specific contexts. MDA can rapidly decrease malaria incidence or transmission, but has a short-lived effect (typically 1–3 months) and should only be used as part of a broader control or elimination strategy. It may be valuable during outbreaks, humanitarian emergencies or service disruptions, particularly in moderate to high transmission areas if high coverage is achieved. In low transmission settings, MDA can reduce residual transmission when combined with strong surveillance, case management and vector control, but is best suited for areas with low malaria importation risk and adequate logistic capacity (49). PDMC targets children recently discharged from hospital after severe malaria, providing preventive treatment during their high-risk recovery period and has demonstrated significant reductions in morbidity and mortality. IPTsc, though not yet widely adopted, is a promising strategy to reduce malaria infections and anaemia in school-aged children in moderate to high transmission areas. These chemoprevention tools should be prioritized and tailored based on local epidemiology, health system capacity, and population risk, and are most effective when integrated with routine prevention and treatment interventions.

Source: Adapted from WHO (2, 3).

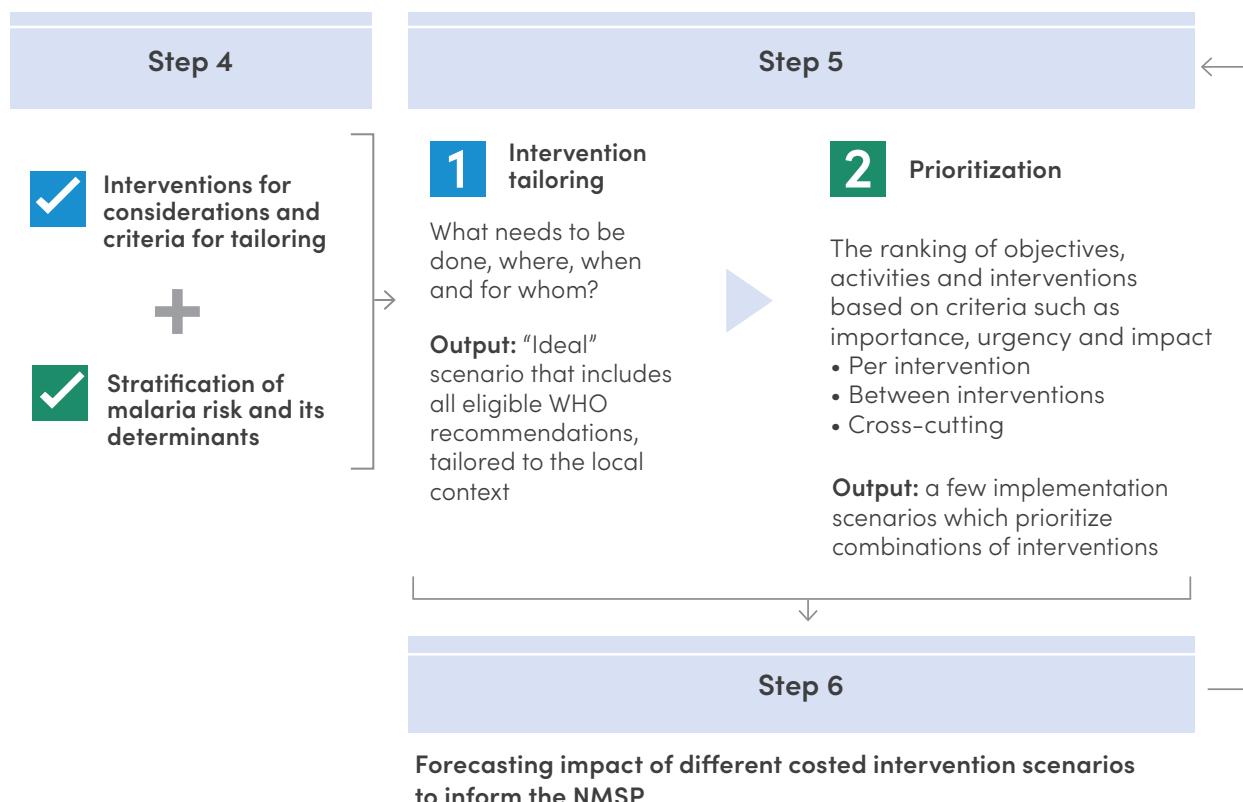
Beyond intervention-specific suggestions, cross-cutting considerations for all interventions include expanding access and addressing inequities, ensuring consistent supply chains for commodities, leveraging community engagement, strengthening monitoring and evaluation systems, and fostering multisectoral collaboration. In addition:

- SNT decisions should align with the broader objectives of the NMP, considering both what can be achieved with other interventions and their associated costs;
- SNT decisions should include various scenarios for intervention coverage, duration, frequency and timing, as well as the costs associated with surveillance and mapping to inform optimal strategies;
- savings from deprioritizing interventions can be allocated to other interventions – the analysis of scaling up or down any intervention must consider the potential impact of reallocating investments to alternative interventions; and
- expansion or deprioritization decisions typically require collaboration with broader health ministry entities – NMP investments can facilitate resources such as commodities and interventions that benefit broader health system objectives.

At the end of this process of tailoring and prioritization, various scenarios will have been formulated (Fig. 12), including:

- one ideal scenario that includes all eligible interventions, following WHO recommendations considered by NMPs, tailored to the local context; and
- a few implementation scenarios with prioritized combinations of interventions (e.g. ranking of interventions according to malaria endemicity).

**Fig. 12. Tailoring interventions based on local context to produce an ideal scenario that encompasses all eligible tailored interventions, and prioritizing combinations of interventions from the ideal scenario to produce multiple implementation scenarios**



The process is iterative, and SNT implementers may decide to first focus on the scenario that includes all eligible tailored interventions, evaluating its impact and estimating its cost before considering prioritized scenarios. In practice, however, all this usually happens simultaneously.

## 2.2.6 Step 6: Forecasting the impact of scenarios based on combinations of interventions

Modelling can help iteratively refine interventions and strategies by simulating the impact of individual or multiple interventions and scenarios on key epidemiological outcomes at different coverage levels. Comparisons should be made relative to the business-as-usual approach as well as between new scenarios (i.e. the ideal scenario that includes all eligible interventions and prioritized implementation scenarios).

Depending on the predictions, there may be a need to refine SNT scenarios or develop new ones. This is especially important when new interventions are being introduced, or previous interventions are to be replaced or removed. While models are unlikely to provide accurate predictions of impact, they are helpful for evaluating trade-offs.

Annex 7 details the use, interpretation and limitations of mathematical models.

Forecasting the impact of different scenarios may give rise to key questions related to intervention tailoring, prioritization of combinations of interventions, and/or resource optimization. Such questions are especially relevant when dealing with resource constraints, but can be revisited as new funding becomes available:

- Should ITNs be scaled back in areas with low baseline transmission or in urban areas where transmission is highly clustered around a small number of hot spots and mass campaigns are likely to yield little impact?
- Should a country introduce malaria vaccines and, if so, where?
- Should IRS be discontinued and replaced with next-generation nets if it is too costly to maintain?
- In the event of scaling back an intervention, what is the likelihood of an epidemic and what contingency plans are in place to prevent and respond to them?
- In SMC-eligible areas where it has not been previously implemented, where case management is high and where severe malaria has reduced considerably, should the country still implement SMC?
- Will a considerable increase in coverage of next-generation ITNs together with PMC be a useful substitute for SMC to further reduce burden in SMC-eligible areas?
- In areas eligible for both SMC and malaria vaccines, which one should be chosen if a country cannot afford both in these areas?
- If IRS is scaled back and replaced with next-generation nets and an epidemic detection, preparedness and response plan is in place, will the addition of chemoprevention and/or vaccines yield just as much impact on burden of disease as full IRS implementation but at lower cost?
- In areas of high severe malaria burden, is the expansion of care through CHWs more effective than the scale-up of SMC and/or vaccines?

- If SMC campaigns can be expanded, should the focus be on increasing coverage within the same areas by including additional age groups or on reaching new areas while maintaining the current age groups?

**Each scenario should be costed** using data from national logistic records, commodity price lists and other available sources, and by quantifying resource needs based on defined coverage targets. Further guidance on costing approaches can be found in Annex 8. Calculating intervention costs provides insight into the feasibility of the different scenarios, especially in relation to available funding. When combined with modelling outputs, economic evaluations help prioritize interventions – whether by geography for a specific intervention, by intervention within a specific geography, or nationally to assess trade-offs between regions and strategies.

At the end of this process, the impact of various scenarios is estimated and visualized. These scenarios may include a business-as-usual approach, full implementation of selected tailored intervention combinations at high coverage in line with national targets, and various implementation options of prioritized intervention combinations based on projected funding levels identified by the NMP and stakeholders. Modelling enables visual comparisons of different plans based on their impact on a selected health outcome, such as incidence, prevalence, severe disease or mortality. Often, multiple end points across different age groups are analysed within the same modelling process. In later stages of prioritization and optimization, additional economic metrics, such as the incremental cost-effectiveness ratio (ICER) or cost per health outcome, can offer further insights.

Several malaria-specific mathematical models are available globally that can support NMPs throughout their SNT process (50, 51). Models must be calibrated using local data and assumptions must be made in collaboration with local malaria experts to ensure the model results are as accurate as possible. Limitations of models, particularly in the ability to quantify credible effective coverage and subsequent impact for an intervention, should be noted. A practical example of how different scenarios can be simulated in an illustrative country can be found in section 2.3.2.

## 2.2.7 Step 7: Selecting strategic scenario for the NMSP

WHO provides standard but tailorabile guidance for countries to adapt for their NMSP processes (11). NMSPs must balance ambitious targets for national development goals within the constraints of operational and resource feasibility. The strategic scenario of intervention combinations in the NMSP should represent national development goals and be informed by generated evidence, established consensus, principals of health equity and the political economy. It may encompass all eligible interventions tailored to the local context at the subnational level and aligned with WHO recommendations or be one of the implementation scenarios of prioritized intervention combinations. In defining these scenarios, it is important to consider how different population groups (e.g. those differentiated by sex, age, socioeconomic status or geographical location) may experience varying levels of access, uptake and impact. This includes assessing which groups are most affected by malaria but least reached by interventions and ensuring that prioritization does not reinforce existing inequities. In addition, the assessment of the feasibility of implementing intervention combinations should take into account

political and administrative boundaries. Applying different combinations of interventions in neighbouring districts within the same province or region may present coordination and acceptability challenges, which could affect operational efficiency and impact.

Prioritization was described as part of step 5, but may also take place during this stage of the NMSP process. This is because defining intervention combination scenarios, simulating their impact, estimating costs and selecting the most effective, evidence-based strategic scenario for the NMSP is an iterative and interconnected process. Each step informs the next, ensuring alignment with national goals while considering equity, and operational and financial feasibility. Important programmatic activities that cannot be reflected in the modelling (e.g. improving surveillance or supervision) should be accounted for in NMSP costing, along with subnational cost variations and data limitations that affect estimate accuracy.

The SNT process allows both the most ambitious scenario (where all eligible interventions following WHO recommendations and tailored to the local context are considered) and prioritized scenarios to be explored under different levels of current and future resource availability. Rather than conducting a full intervention prioritization process each time new resources become available, the NMSP can include multiple implementation scenarios of prioritized interventions at different cost levels to guide investment decisions throughout its lifespan. These scenarios should include considerations of which groups may benefit or be left behind under each cost envelope, enabling more informed, just and accountable decision-making.

This phase may give rise to several important questions and flexibility may be required in the way WHO-recommended interventions are adopted by countries to support effective prioritization.

- What coverage of interventions does the country need to achieve in each population group or operational unit to meet national targets?
- What financial and other resources are needed to achieve the coverage required to meet national targets?
- What financial and other resources are likely to be available during the lifespan of the NMSP?
- What prioritization approach should the country adopt if resources are limited:
  - maintain the business-as-usual approach, keeping existing interventions and strategies as is and sustaining current coverage levels;
  - implement all interventions identified during the SNT but with lower coverage;
  - implement all interventions identified during the SNT at high coverage but with reduced geographical scope for some interventions or focused on only certain population groups;
  - scale back some interventions to maintain high coverage for others or enable introduction of new ones;
  - not introduce new interventions and so maintain existing interventions at high coverage; or
  - consider other relevant options?

With these considerations in mind, policy-makers can prioritize interventions using various tools, including ranking interventions or geographical areas based on threshold values from intervention stratifications (e.g. prioritizing higher malaria endemic places) and/or ranking interventions by impact (e.g. based on robust modelling outputs).

Selected strategic scenarios of intervention combinations should be evidence-based, aligned with national strategic goals and equity principles, and adapted to local realities. By prioritizing the most impactful and feasible interventions, this step lays the foundation for optimizing resources and maximizing health outcomes in later stages of the malaria response. A costed NMSP enables countries to advocate effectively with donors and partners, and ensure transparency and accountability, enhancing the impact and sustainability of malaria control and elimination efforts.

## 2.2.8 Step 8: Optimizing strategic scenario within available resources

The NMSP serves as the basis for selecting intervention combinations in which identified needs and available resources are aligned. Eventually, the strategic scenario in the NMSP should be optimized for different resource envelopes, including the currently available funding and potential increases or decreases in funding.

The strategic scenario in the NMSP can be optimized within different budget constraints using various approaches, such as scaling back or removing low-priority interventions based on previously prioritized implementation scenarios; reallocating resources through cost-effectiveness analyses and mathematical models; and addressing operational inefficiencies in delivery (i.e. examining not only which interventions are feasible within the budget but also how they are delivered, who is being reached and who may be excluded, underserved or disproportionately affected).

The cost-effectiveness approaches outlined in Annex 9 are crucial for assessing trade-offs and guiding intervention decisions. Selecting the most cost-effective plan involves ensuring it fits within budget constraints and maximizes impact with available funds. An affordable plan may not always achieve the level of impact required to meet national goals, so alternative strategies should be explored. Equity considerations should be integrated alongside cost-effectiveness to avoid deprioritizing high-impact but less cost-efficient interventions for vulnerable populations. This phase is particularly challenging, as it often requires deprioritizing important interventions and activities outlined in the NMSP.

In addition to CEA, countries should also consider opportunities to reduce the costs of interventions themselves without compromising quality or effectiveness. Improving cost efficiency can help health systems make better use of available resources and enhance the value for money of interventions, even when they are already considered effective.

Approaches include:

- **improving procurement efficiency** – aggregating procurement across regions or programmes, securing lower prices through bulk purchasing, or using competitive bidding processes;
- **reducing delivery costs** – streamlining distribution systems, integrating services or using task-shifting approaches to reduce labour and logistics costs;

- **leveraging community-based delivery models** – these may reduce facility-based delivery costs and improve coverage; and
- **using digital tools and data systems** – optimizing stock management, targeting delivery and reducing wastage.

These strategies should be integrated into routine programme planning and reviewed regularly to identify areas of inefficiency. These efforts can also feed into CEA by providing updated and more accurate cost inputs for analysis.

Some key considerations for resource optimization are described below.

- A collaborative approach, engaging stakeholders involved in budgeting and funding, will ensure alignment between intervention priorities and financial planning, and allow joint accountability of operational plans.
- Costing should be conducted for each subnational unit, as comparisons of national estimates of cost-effectiveness may mask the varying costs and potential impact of different interventions. Assessing subnational cost-effectiveness requires considerable investment in high-quality data, not only for calibration of the transmission dynamic models but also to understand the cost of intervention delivery, monitoring, evaluation and response. The cost-effectiveness analysis also requires absolute estimates of gains in malaria reductions predicted for each scenario. Countries must be confident in the accuracy of the models they use for such predictions.
- A choice must be made whether to use a financial costing or economic costing model. The former focuses on direct budget; the latter includes resources that contribute to malaria response that are outside the consideration of the current budget, such as some health system factors.
- The optimization process is a balance between maximum impact with available resources and necessary considerations for equity, fairness and other factors involved in a value-based health-care approach.

The SNT process is iterative: reprioritization and subsequent optimization may be required to inform reprogramming or reorientation as new resources become available or as resources are scaled down within the lifespan of the NMSP. Using the strategic scenario as a reference against optimized scenarios will help quantify unfunded interventions and guide decision-making during reprogramming or when additional resources become available. Also, countries may implement mid-term reviews of their NMSP, leading to a need to reorient implementation. Reprioritization and optimization may also be required in response to a change in market dynamics change or if the cost of interventions goes up. A practical example of optimization of strategic scenario in a theoretical country can be found in section 2.3.3.

In conclusion, optimization helps to refine strategy into actionable, cost-efficient plans that ensure the most effective and equitable use of available resources. The optimized scenario within the currently available budget forms the basis for the costed operational plan, which assigns actionable, costed steps to each activity supporting the scenario. Attention should be given to factors that influence the overall cost and scale of interventions, including commodity quantification, delivery strategies, distribution channels, microplanning, implementation periodicity, monitoring and evaluation,

social-behavioural interventions and waste management. By utilizing data-driven approaches, scenario planning and continuous feedback, the optimization step allows malaria programmes to achieve maximum impact, even in resource-constrained environments, while ensuring that strategies are responsive to inequities across sex, socioeconomic status and other dimensions.

## 2.2.9 Steps 9 and 10: Delivering services, monitoring and evaluation of impact

This phase is not specific to SNT and corresponds to the implementation of the malaria programme. It includes interventions and activities outlined in the costed operational plan, as well as maintaining, scaling up or scaling down specific interventions.

Monitoring and evaluation must be central to programme planning and delivery. This requires clear objectives, indicators and expected outcomes for each intervention. Logical frameworks should outline the relationships between inputs, outputs and outcomes, facilitating structured data collection, periodic evaluations and final impact assessments. SNT steps should align with key programme performance indicators, such as intervention coverage, reductions in malaria incidence and prevalence, and access to diagnostics and treatment. Standardized templates for data collection and reporting ensure consistency across operational units, and dashboards offer real-time visualizations to support decision-making. Monitoring and evaluation activities should be linked to an appropriate response in a timely manner to address the observed gaps. Adaptive implementation protocols are essential, enabling adjustments based on monitoring and evaluation findings (e.g. modifying strategies when resistance patterns or operational challenges are identified). Capacity strengthening is another cornerstone of effective monitoring and evaluation. Training programmes should equip staff with skills in using monitoring and evaluation tools, interpreting data and preparing reports. They should foster awareness of gender and equity considerations to ensure data collection and analysis reflect diverse population needs. This awareness includes understanding how gender norms or barriers in access to health services may influence vulnerability and effectiveness of the combination of interventions. Partnerships with research institutions can enhance technical capacity. Community engagement in data collection and evaluation fosters local ownership and ensures interventions are contextually appropriate and inclusive. Investment in monitoring and evaluation – including resources for delivery, supply chain systems, surveillance, data, data systems such as NMDRs, and analytical capacity – is crucial to ensure programme performance, assess impact and enable future evidence-based reprioritization of interventions and optimization of resources.

It is also recommended to monitor and evaluate the SNT process, its implementation and its impact. This includes the analytical questions defined, the approach taken to answer these questions (including analytical methods, stakeholders and the timelines to implement the approach), data gaps identified (e.g. issues with data quality or availability), key findings, and whether the findings were used. Annex 10, section A10.1, provides details about building a stronger surveillance system to ensure effective monitoring and evaluation. Annex 10, section A10.2, provides guidance and a checklist for SNT monitoring and evaluation.

## 2.3 Illustrative country example

This section presents an illustrative example for the fictitious Country X to demonstrate the process of tailoring major malaria interventions and strategies.



**This example is not intended as a standardized approach or a set of prescriptive recommendations.**

**The programme leading the SNT process should determine, through collaboration with key stakeholders, which factors to use in prioritizing interventions and which thresholds to apply when stratifying malaria risk and interventions. For instance, countries may choose different cut-off values based on their specific context (e.g. quantiles or the distribution of estimates).**

This example includes:

- stratifying malaria risk and its determinants (step 4);
- designing various scenarios, such as one that incorporates eligible WHO-recommended interventions considered by NMPs and tailored to local context, along with implementation scenarios that prioritize specific intervention combinations (step 5);
- assessing the impact of intervention combinations through mathematical models (step 6);
- selecting the strategic scenarios for the NMSP (step 7); and
- optimizing the plan once the available budget is determined (step 8).

### 2.3.1 Illustrative country example: stratification and intervention tailoring

#### 2.3.1.1 Stratifying malaria risk

Malaria interventions should be tailored based on transmission intensity and its determinants. Case management is universally required. Annex 5, section A5.1, provides information on how to stratify malaria risk. This includes prevalence, incidence (and how to adjust for reporting, completeness and access-to-care biases) and mortality metrics, which threshold can be used, and how to combine different risk metrics into a single, stratified composite malaria risk metric that will inform which operational units are eligible for which intervention or strategy.

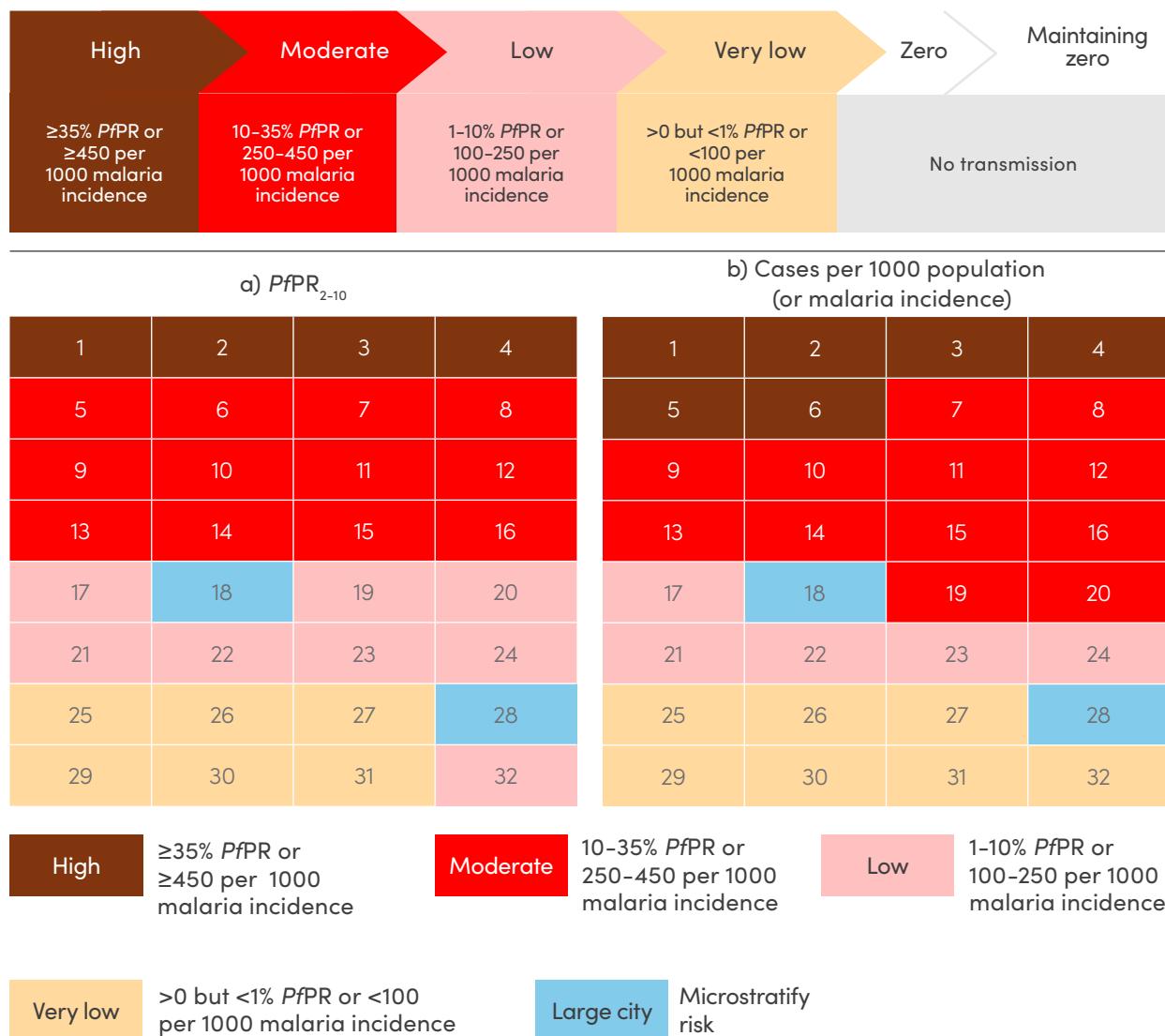
Country X has 32 operational units (districts) covering the entire transmission continuum, except malaria-free areas. Fig. 13 shows malaria risk stratification for Country X using:

- parasite prevalence ( $PfPR_{2-10}$ ), estimated from household survey data – there are four districts with high transmission, 12 with moderate transmission, eight with low transmission and six with very low transmission, and there are two urban areas (large cities); and
- malaria incidence (or annual parasite incidence), estimated from routine case detection data – there are six districts with high malaria transmission, 12 with

moderate transmission, five with low transmission and seven with very low transmission, and there are the same two urban areas (large cities).

Note that the incidence and prevalence thresholds used to define strata categories are the ones suggested by WHO (17), but these could be adapted based on context.

**Fig. 13 Malaria risk stratification comparing a) parasite prevalence and b) incidence metrics for Country X**



*PfPR:* Plasmodium falciparum prevalence rate.

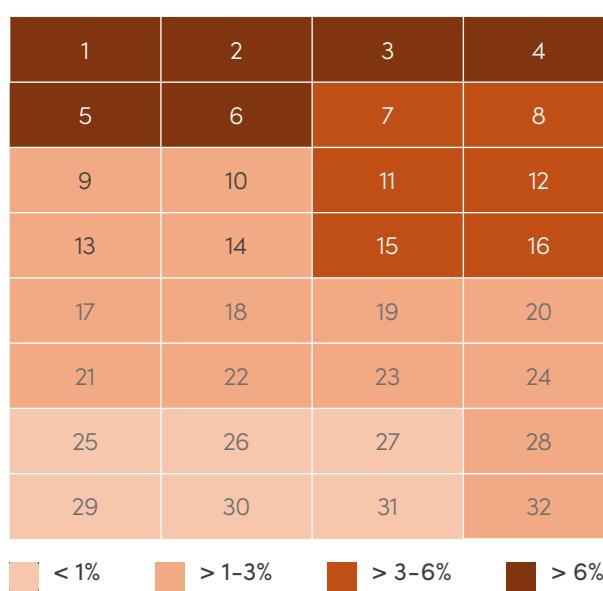
Note: urban classification is not based on malaria risk but rather on socioeconomic factors.

Note that there are differences in the stratification by transmission using  $PfPR_{2-10}$  and malaria incidence as each metric measures a different thing (the former measures malaria infection at a specific point in time, while the latter measures diagnosed malaria cases during a defined period). Two districts (5 and 6) have high transmission under malaria incidence, but moderate transmission under  $PfPR_{2-10}$ , while districts 19 and 20 have moderate transmission using malaria incidence but low transmission using  $PfPR_{2-10}$ . District 32 has low transmission using  $PfPR_{2-10}$  but very low transmission using

malaria incidence. There is usually minimal variation in decisions to tailor interventions between moderate and high transmission; however, the difference may become important during the intervention prioritization process. Decisions will change between moderate and low, and between low and very low transmission levels. When faced with such discrepancies in malaria risk stratification, programmes should decide, based on data availability and quality, whether one of the two metrics or a combination of both best represents their situation.

Other metrics representing epidemiological indicators should be stratified, including malaria mortality (Fig. 14).

**Fig. 14. Malaria risk stratification using mortality data (probability of death before the age of 5 years) for Country X**



### 2.3.1.2 Stratifying and tailoring: case management

Routine case management is required everywhere, even in areas without malaria transmission (in case malaria cases are imported). Decisions as to whether to strengthen case management can be informed by comprehensive assessment of key case management components, including access to care, stock out, access, use and adherence to diagnostics or treatments, quality of care, and supervision of health facilities. Annex 5, section 5.2, provides detail on how to stratify access and quality of care for case management.

Understanding the root cause(s) for any particular performance level is essential. Decisions are often linked to the following factors.

- **Current need for diagnosis and treatment in the public sector.** Understanding the location and number of health facilities, CHWs and fever cases, and malaria prevalence is crucial. High-quality malaria data and georeferenced health information are essential for assessing the demand for services and identifying the need for new providers.

- **Level of access to care by operational unit.** Access to care can be evaluated by analysing treatment-seeking behaviours, geographical proximity to health facilities and population distribution. Identifying areas with inadequate access can inform decisions on expanding the use of CHWs, while aligning with national health plans.
- **Burden of severe malaria by operational unit.** A high burden of severe malaria often signals issues such as high transmission, low access to care or poor quality of care. Expanding access to timely and effective treatment is essential. In line with WHO recommendations, prereferral treatment with either rectal or intramuscular artesunate should be considered in remote areas where referral to higher level care may be delayed. In settings with high rates of severe malaria admissions, post-discharge malaria chemoprevention (PDMC) should also be considered to reduce the risk of recurrent malaria and death among recently hospitalized children.
- **Burden of all-cause under-five mortality by operational unit.** High under-five mortality linked to malaria may point to issues such as low access to prompt care, poor quality of care, poor compliance to first-line treatment or resistance of the parasite to the first-line treatment. It is important to address the root causes by focusing on prevention, case management and improvement of hospital care, including health worker training and availability of necessary medical resources.

Countries often face the decision of where to scale up CHWs to address gaps in malaria case management. This choice affects all four key access-to-care questions listed above. Since many factors affecting malaria management are systemic and extend beyond malaria programmes, it is essential to engage relevant health ministry departments in the SNT process. Additionally, countries are encouraged to refer to WHO integrated community case management (iCCM) guidelines for further guidance (52).

Key factors to consider when allocating CHWs include the distribution of febrile burden in children, all-cause under-five mortality, malaria transmission and burden, and geographical gaps in access to malaria case management. The combination of these factors should inform decisions, noting that CHWs aim to treat childhood illnesses, not just malaria, and therefore malaria-only information should not form the sole basis for their establishment. In the Country X example, we have information on malaria transmission, all-cause under-five mortality, treatment for fever in children and population within 5 km or 1 hour of a health facility.

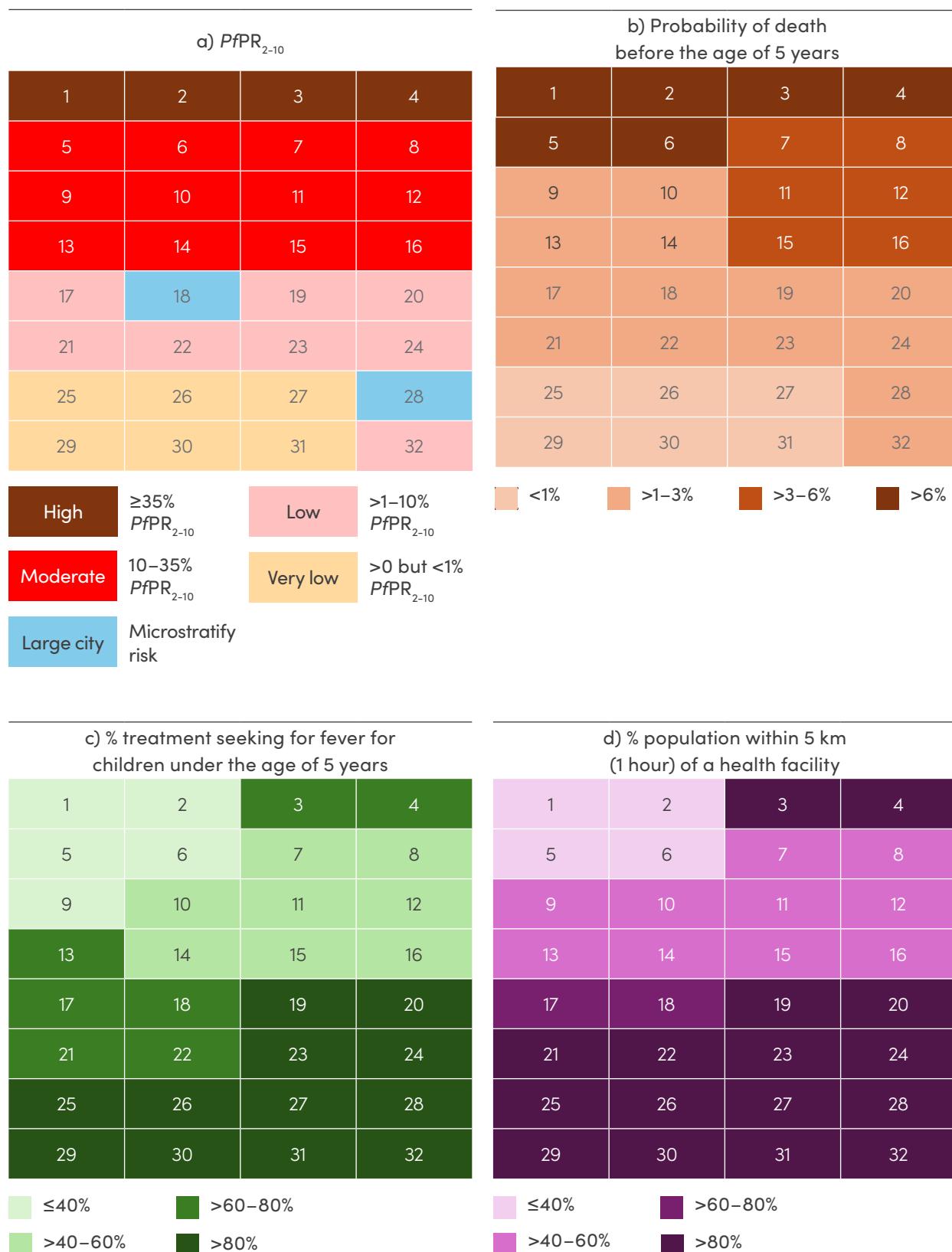
For Country X, districts for CHW scale-up can be identified using , the following algorithm, which has been designed to be flexible and adaptable to the local context.

- Exclude urban districts.
- Include districts that have high all-cause under-five mortality categories ( $> 3\%$  probability of death).
- Only include districts with moderate and high transmission ( $> 10\% \text{ PfPR}_{2-10}$ ). When setting a transmission threshold, consider the potential exclusion of high-mortality districts where malaria is not the primary driver. From a broader disease burden reduction perspective, prioritizing all-cause mortality over disease-specific criteria may lead to greater overall health impact and save more lives.
- Include districts with below 60% treatment-seeking.

- Include districts with less than 60% of the population within 5 km (or 1 hour) of a health facility.

These criteria are presented in Fig. 15.

**Fig. 15. Metrics stratified to inform the expansion of care through CHWs in Country X**



The 10 districts identified for CHW scale-up based on the criteria in Fig. 15 are shown in Fig. 16. These districts are rural, within the two highest categories of child mortality and malaria risk and the two lowest categories of treatment-seeking and geographical access to care. The criteria are illustrative and should be adjusted to local context. Within these districts, information on the anticipated construction of new PHC facilities should be included to refine targeting, either at this point or in the quantification of geographical access if the location of future facilities is known. In areas excluded from CHW scale-up, additional activities to improve treatment-seeking and quality care should be considered. Further refinements may be made to tailor CHW scale-up, such as the distribution of severe malaria commodities. The exclusion of urban areas from CHW scale-up may be warranted if there are other ways of reaching the most underserved populations, including through the private sector or tailored subsidy schemes.

**Fig. 16. Districts (in blue) considered for CHW expansion in Country X**

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20
21	22	23	24
25	26	27	28
29	30	31	32

### 2.3.1.3 Stratifying, tailoring and prioritizing: vector control interventions

The tailoring of vector control interventions should be guided by a careful analysis of malaria risk and relevant operational data. Key considerations include historical intervention coverage and outcomes, trends in malaria transmission, entomological surveillance findings, and patterns of insecticide resistance. For instance, IRS is typically more costly than ITNs on a per-person-protected basis and is generally not recommended for deployment alongside ITNs in the same area, except as part of a deliberate insecticide-resistance management strategy. In areas where ongoing IRS programmes have significantly reduced malaria burden, withdrawing IRS without a suitable replacement may lead to resurgence. In such situations, if IRS continuation is not feasible, countries should explore alternative strategies, such as deploying next-generation ITNs, intensifying case management, and enhancing epidemic surveillance and preparedness. In certain ecological settings with identifiable and stable breeding sites, LSM may be considered as a complementary intervention, provided there is sufficient capacity and operational feasibility. Annex 6 details considerations for deploying, tailoring and prioritizing vector control interventions.

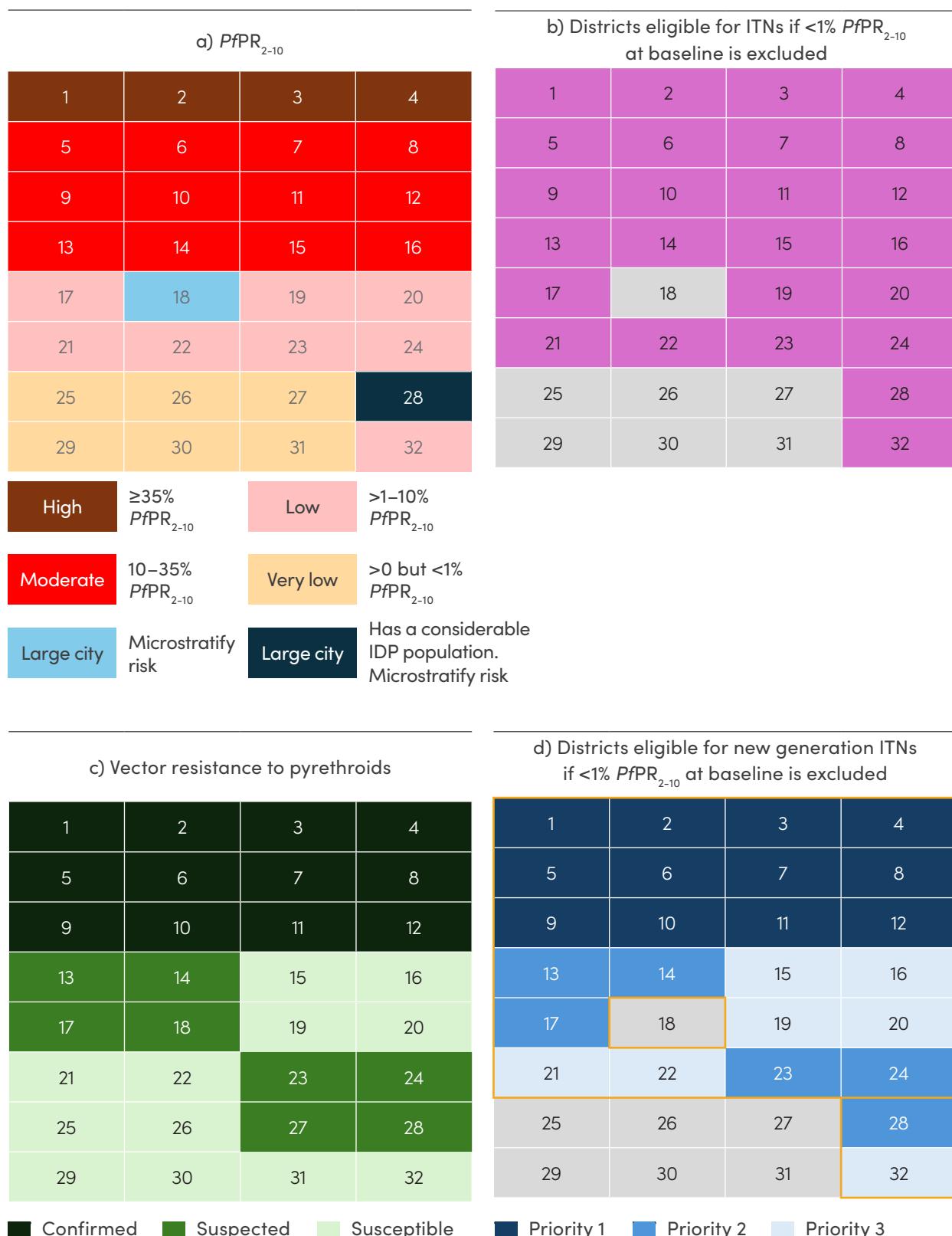
## Insecticide-treated nets

- Exclude areas where vectors are exclusively or predominantly outdoor-biting or outdoor-resting, as ITNs are less effective in such settings. There is no universally accepted threshold for defining predominant outdoor biting, as it depends on local vector and human behaviour, particularly where people are during peak biting hours. One approach involves calculating behaviour-adjusted exposure, where outdoor biting is considered predominant if more than 50% of infectious bites occur while people are outdoors (53).
- Tailor decisions based on local data on vector behaviour and resistance patterns (though insecticide-resistance patterns influence the choice of net type, they are not typically used to determine where ITNs should be deployed).
- Exclude all or parts of urban areas based on risk microstratification, type of vectors, housing infrastructure and the coverage and quality of case management. Incorporate environmental assessments and community insights. For further guidance, refer to the *Global framework for response to malaria in urban areas* (54) and the *Guiding principles for prioritizing malaria interventions to achieve maximum impact* (3).
- Exclude areas where both baseline and current transmission are low or very low (e.g. < 1%  $PfPR_{2-10}$  or < 5%  $PfPR_{2-10}$  depending on context).
- Exclude areas where IRS implementation is ongoing unless the IRS programme is unsustainable and there is a planned transition to ITNs.
- Include high-risk populations, such as internally displaced persons or mobile migrant populations, even in areas otherwise excluded, if ITNs are considered an interim appropriate vector control intervention.
- The type of nets to be deployed in an area should be guided by the insecticide-resistance data. Areas with documented high pyrethroid resistance should be prioritized for next-generation ITNs (e.g. pyrethroid-chlorfenapyr nets) where resistance data is available. Deploy pyrethroid-only ITNs in areas with confirmed vector susceptibility or as a transitional measure while scaling up next-generation products.

Fig. 17 illustrates SNT of ITNs for Country X. This does not constitute a standardized approach; each factor used to prioritize and thresholds to stratify should be revised depending on local context. It is assumed that there is no scale-up of IRS, all vectors are assumed to be predominantly indoor-biting, with a large proportion also indoor-resting, making ITNs suitable to settings where there is information on pyrethroid resistance and high-risk populations.

- Districts with  $PfPR > 1\%$  are eligible for ITN distribution.
- District 28 qualifies for ITNs due to its large population of internally displaced persons.
- When considering pyrethroid resistance, districts with confirmed resistance are the highest priority (priority 1) for scaling up next-generation ITNs, followed by districts with suspected resistance (priority 2), and districts where vectors remain susceptible (priority 3).

Based on these criteria for Country X, 25 districts were eligible for ITN – 12 as first priority, six as second priority and seven as third priority.

**Fig. 17.** ITN targeting in Country X

IDP: internally displaced persons.

## Indoor residual spraying

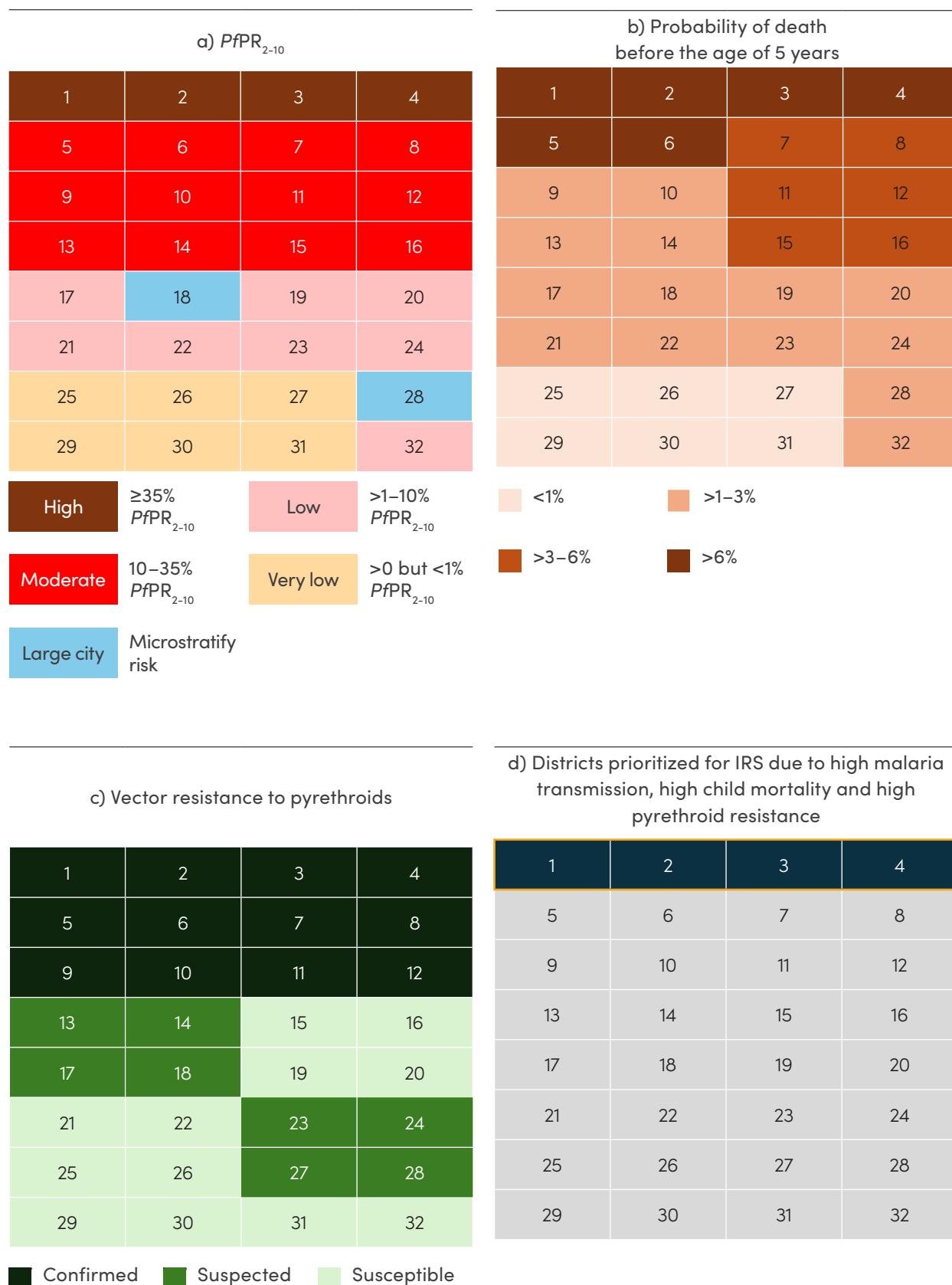
The basic entomological criteria for scaling up IRS are similar to that of ITNs. At current prices, IRS is more expensive than ITNs per population at risk protected and is not recommended together with ITNs (2). Information on malaria burden and insecticide resistance should be key in decision-making.

In this example, Country X targets IRS in the districts with highest malaria transmission (> 35%), highest under-five mortality (> 6%) and confirmed pyrethroid resistance (Fig. 18). As a result, four districts are targeted for IRS. (Note that the criteria are illustrative and should be adjusted to local context.)

If a country's ongoing IRS programme has achieved significantly reduced transmission and burden, scaling back IRS poses a high risk of an epidemic. If IRS continuation is not feasible, alternative measures, such as next-generation nets, intensified case management, strengthened epidemic surveillance, and enhanced epidemic preparedness and response, must be in place. In certain situations, IRS may still be used to target vulnerable populations where other vector control options are impracticable (e.g. prisons, psychiatric hospitals).

### 2.3.1.4 Stratifying, tailoring and prioritizing chemoprevention interventions

Tailoring chemoprevention interventions requires alignment with the local malaria epidemiology, population risk profiles, and the readiness of delivery platforms. Interventions such as IPTp, PMC, SMC and PDMC each have specific target populations, delivery channels and eligibility criteria. Decisions should be guided by factors such as transmission intensity and seasonality, age-specific disease burden, patterns of severe malaria, and coverage of ANC and routine immunization services. For example, SMC is suitable in areas with short, intense transmission seasons, while PMC may be more appropriate where young children experience severe disease throughout the year. IPTp requires moderate to high transmission and reliable ANC attendance. Tailoring should also account for subnational variations in care-seeking behaviour, health worker capacity, and the feasibility of community-based delivery, especially for interventions like PDMC and SMC. Reviewing past coverage data and evaluating delivery bottlenecks is essential to ensure that chemoprevention strategies are both impactful and operationally feasible. Annex 6 details considerations for deploying, tailoring and prioritizing chemoprevention interventions. This illustrative example for Country X focuses on stratifying and tailoring SMC, PMC and IPTp, but there are other chemoprevention interventions such as IPTsc, PDMC and MDA that a programme may choose to implement.

**Fig. 18.** Districts identified to be priority for IRS implementation in Country X

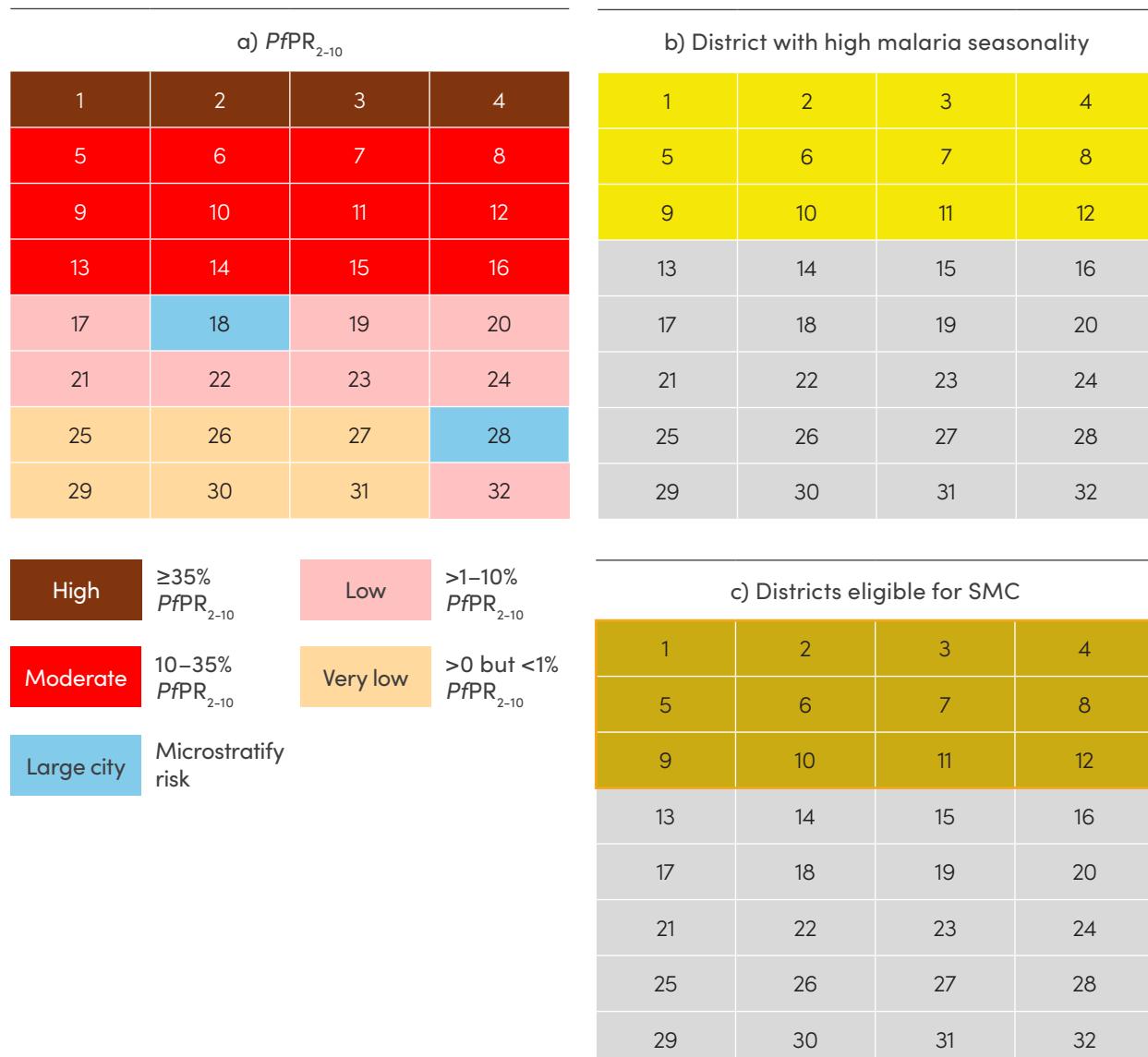
## Seasonal malaria chemoprevention

SMC is recommended for scale-up in areas of seasonal malaria transmission for children belonging to age groups at high risk of severe malaria. SMC should be implemented during peak malaria transmission seasons to reduce disease burden (44). In addition to the epidemiological and seasonality conditions for SMC, consideration of factors related to delivery, acceptance, compliance, resistance monitoring, and monitoring and evaluation should all be included in decision-making.

In situations where countries need to decide to scale back SMC, the principle of “least harm” should apply, just as is applied to other interventions. In the case of SMC, areas with lowest baseline transmission, those with high levels of access to quality case management and those with alternative prevention mechanisms may be considered.

In this example, Country X targets SMC in areas with current moderate or higher levels of transmission ( $PfPR > 10\%$ ) and with the required levels of seasonality (Fig. 19). As result, 12 districts (districts 1–12) were found eligible for SMC.

**Fig. 19. SMC eligibility by district in Country X**

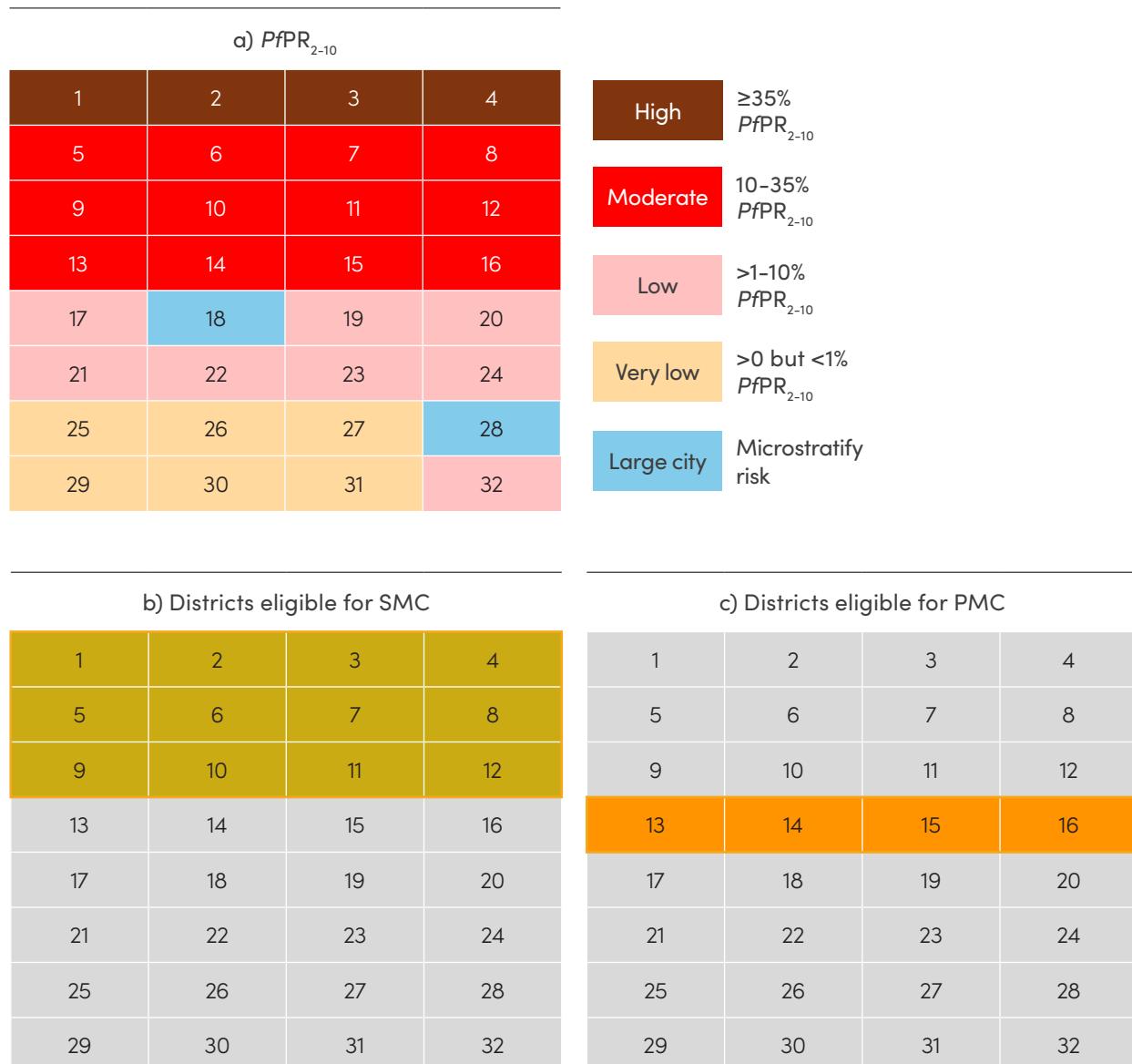


## Perennial malaria chemoprevention

PMC is considered for use in areas of high and moderate transmission and where severe disease is concentrated in children under the age of 5 years. PMC and SMC should not be co-deployed. PMC is delivered through the EPI platform, with coverage levels determined by routine immunization rates for the eligible age group. Age-related dosing and coverage challenges must also be considered. Therefore, when finalizing PMC within intervention and strategy combinations, factors such as delivery feasibility, compliance, and monitoring and evaluation should be considered.

In Country X, the combination of areas with moderate and high transmission and exclusion of SMC-eligible areas shows that four districts (districts 13–16) are eligible for PMC (Fig. 20).

**Fig. 20. PMC eligible districts in Country X**



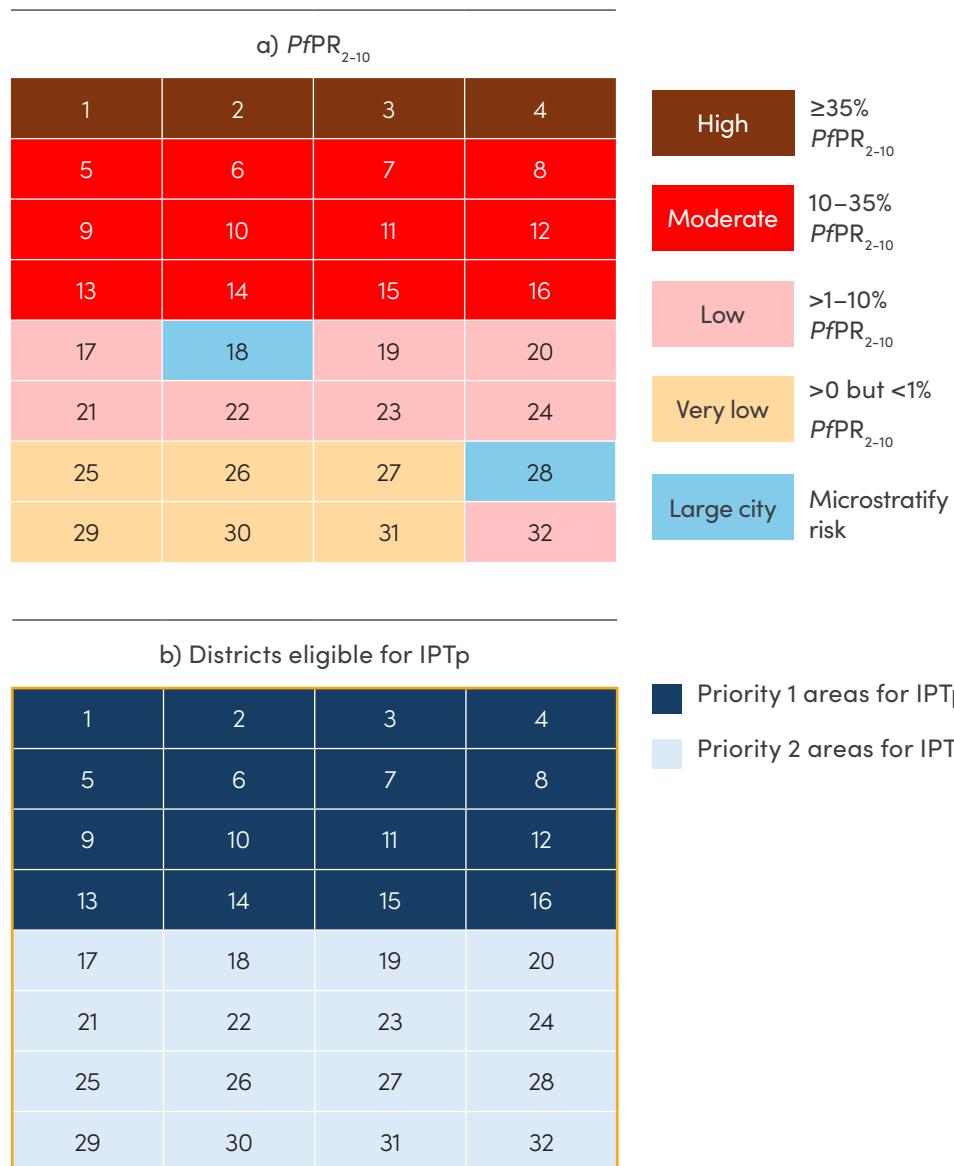
## Intermittent preventive treatment in pregnancy

In malaria endemic areas, pregnant women and girls of all gravitudes should be given antimalarial medicine at predetermined intervals to reduce disease burden in pregnancy and adverse pregnancy and birth outcomes (2). ANC contacts remain an important platform for delivering IPTp. While IPTp is cost-effective due to low sulfadoxine pyrimethamine (SP) costs and ANC-based delivery, coverage may be hindered by inconsistent SP provision, treatment compliance and ANC access.

Scale-up requires investment in monitoring, health worker training, social behaviour change, and private-sector engagement to expand delivery.

In the Country X example, moderate and high transmission areas ( $PfPR > 10\%$ ) are considered first priority for geographical tailoring of IPTp (Fig. 21). As a result, 16 districts (districts 1–16) were found eligible and high priority for IPTp.

**Fig. 21. Districts eligible for IPTp in Country X**

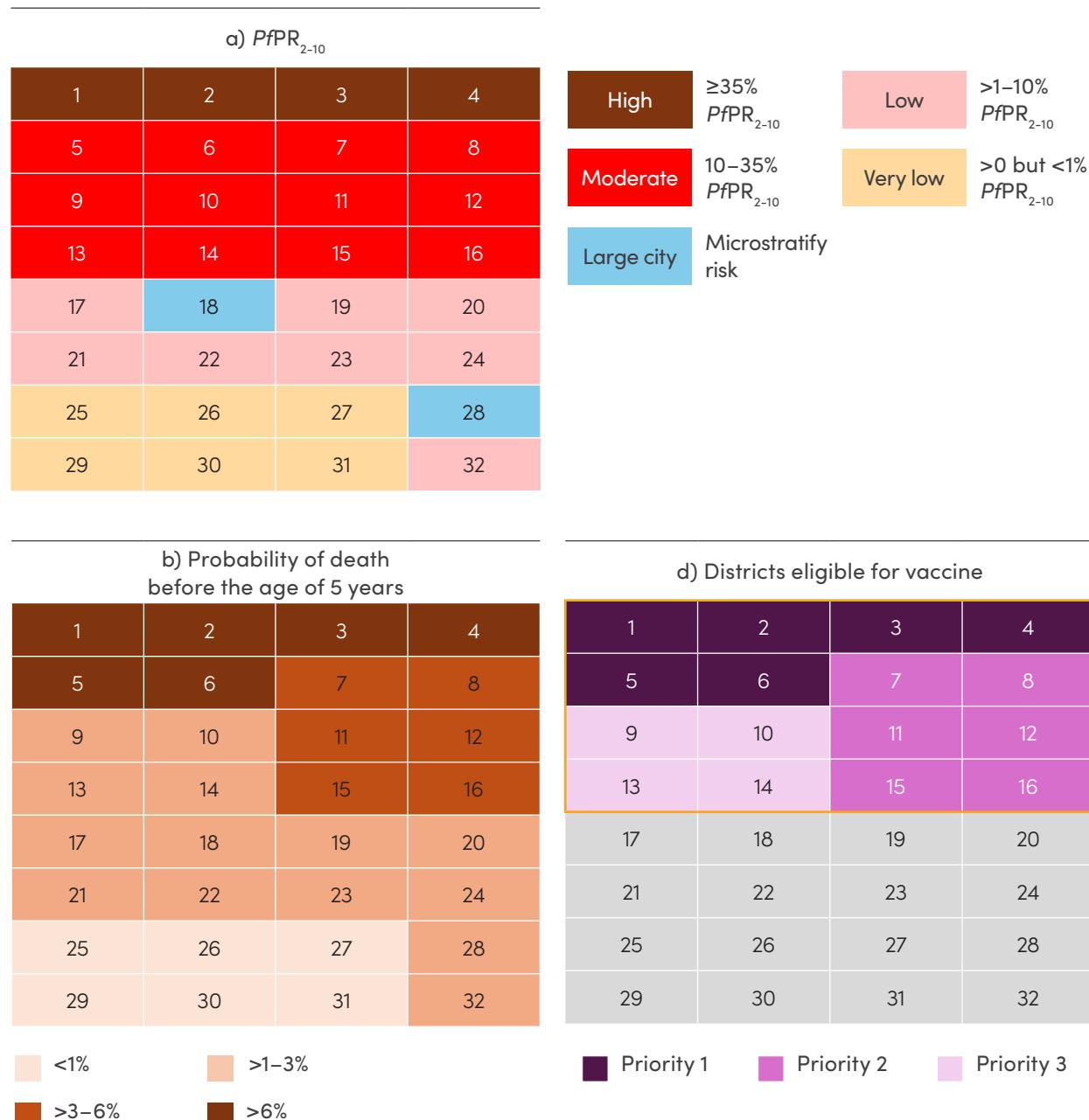


### 2.3.1.5 Stratification, tailoring and prioritizing: malaria vaccines

Malaria vaccines to prevent *P. falciparum* malaria in children should be considered in areas of moderate and high transmission. The primary channel for malaria vaccine delivery is the immunization platform, using fixed immunization clinics and outreach.

In this illustrative example, which does not represent a standardized approach (the selection of factors used to tailor and prioritize interventions, as well as the thresholds for stratification, should be adapted based on the local context). Mortality was used as a possible criterion for further prioritization. In Country X, prioritizing malaria vaccine to higher endemicity and mortality districts will result in six districts in high priority (where  $PfPR \geq 35\%$  and/or mortality  $\geq 6\%$ ), six at medium priority (where  $PfPR = 10\text{--}35\%$  and mortality  $> 3\text{--}6\%$ ) and four at low priority (where  $PfPR = 10\text{--}35\%$  and mortality  $> 1\text{--}3\%$  (Fig. 22).

**Fig. 22.** Districts eligible for malaria vaccine in Country X



### 2.3.1.6 Combining all tailored individual interventions into an ideal scenario of intervention combinations

All individual appropriate and targeted malaria interventions and strategies are combined in an ideal scenario – a final package of interventions for each operational unit that encompasses all eligible interventions following WHO recommendations considered by NMPs and tailored to local context and factors (Fig. 23).

**Fig. 23. Intervention combinations for the ideal scenario – eligible interventions following WHO recommendations considered by NMPs and tailored to local context and factors in Country X before prioritization**

 This scenario is for illustrative purposes; countries may have more or fewer interventions and strategies.

1 CM, CHW, ITN or IRS, SMC, IPTp, vaccine	2 CM, CHW, ITN or IRS, SMC, IPTp, vaccine	3 CM, ITN or IRS, SMC, IPTp, vaccine	4 CM, ITN or IRS, SMC, IPTp, vaccine
5 CM, CHW, ITN, SMC, IPTp, vaccine	6 CM, CHW, ITN, SMC, IPTp, vaccine	7 CM, CHW, ITN, SMC, IPTp, vaccine	8 CM, CHW, ITN, SMC, IPTp, vaccine
9 CM, ITN, SMC, IPTp, vaccine	10 CM, ITN, SMC, IPTp, vaccine	11 CM, CHW, ITN, SMC, IPTp, vaccine	12 CM, CHW, ITN, SMC, IPTp, vaccine
13 CM, ITN, PMC, IPTp, vaccine	14 CM, ITN, PMC, IPTp, vaccine	15 CM, CHW, ITN, PMC, IPTp, vaccine	16 CM, CHW, ITN, PMC, IPTp, vaccine
17 CM, ITN, IPTp	18 CM, IPTp	19 CM, ITN, IPTp	20 CM, ITN, IPTp
21 CM, ITN, IPTp	22 CM, ITN, IPTp	23 CM, ITN, IPTp	24 CM, ITN, IPTp
25 CM, IPTp	26 CM, IPTp	27 CM, IPTp	28 CM, ITN, IPTp
29 CM, IPTp	30 CM, IPTp	31 CM, IPTp	32 CM, ITN, IPTp

CHW: community health worker; CM: case management; IPTp: intermittent preventive treatment in pregnancy; IRS: indoor residual spraying; ITN: insecticide-treated net; SMC: seasonal malaria chemoprevention.

## 2.3.2 Illustrative country example: forecasting the impact of intervention combinations

The first step in forecasting the impact of intervention combinations should be to estimate the achievable impact and cost of scaling all eligible interventions and strategies (e.g. those in Fig. 23) to high coverage levels in each operational unit. This approach serves two key purposes.

- If the estimated impact falls significantly short of national health and development targets, it indicates that these goals may be unrealistic within the strategy's time frame, requiring a revision of NMSP goals.
- If the estimated impact aligns with national goals or if goals are adjusted accordingly, the next step is to focus on a few feasible implementation scenarios of prioritized intervention combinations.

When stratifying and tailoring interventions to the local context, Country X had already applied some prioritization criteria (e.g. prioritizing areas of higher malaria endemicity or mortality, or places with high resistance or low access to care). Note that other methods can be used to inform prioritization (e.g. the use of mathematical models to assess which intervention combinations can achieve expected impact and country goals).

The prioritization criteria applied by Country X formed the basis for two implementation scenarios. If implemented, these approaches would lead to the maps of intervention combinations shown in Fig. 24.

### 2.3.2.1 Implementation scenarios of prioritized combinations of interventions for Country X

Implementation scenario 1: priority 1 and 2 interventions (for interventions where priority criteria were used to stratify interventions)

- Expand CHWs in all eligible districts (not urban, > 10% mortality rate, > 10% PfPR, < 60% treatment-seeking and < 60% within 5 km of a facility).
- Scale up next-generation ITNs in first/highest and second/medium priority districts (not urban except with internally displaced persons, with indoor-biting/indoor-resting, PfPR > 1%, no IRS, prioritize areas with confirmed and suspected resistance).
- Implement IRS in all eligible districts but not together with ITNs (not urban, PfPR > 35%, mortality > 15%, confirmed resistance).
- Implement SMC across all eligible districts (not urban, PfPR > 10%, required seasonality).
- Implement PMC in all eligible districts (PfPR > 10%, no SMC).
- Implement IPTp in all districts (PfPR > 10%).
- Implement the malaria vaccine in first highest and second medium priority districts (PfPR > 10% and mortality > 3%).

Implementation scenario 2: only priority 1 interventions (for interventions where priority criteria were used to stratify interventions) and no IRS

- Expand CHWs in all eligible districts (not urban, > 10% mortality rate, > 10% PfPR, < 60% treatment-seeking and < 60% within 5 km of a facility).

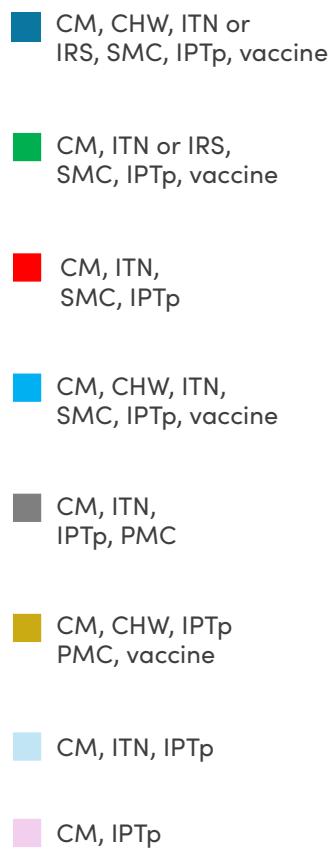
- Scale up next-generation ITNs in first/highest priority districts (not urban except with internally displaced persons, with indoor-biting/indoor-resting,  $PfPR > 1\%$ , no IRS, prioritize areas with confirmed resistance).
- Do not implement IRS anywhere and instead use ITNs.
- Implement SMC across all eligible districts (not urban,  $PfPR > 10\%$ , required seasonality).
- Implement PMC in all eligible districts ( $PfPR > 10\%$ , no SMC).
- Implement IPTp in first/highest priority districts ( $PfPR > 10\%$ ).
- Implement the malaria vaccine in first/highest priority districts ( $PfPR > 10\%$  and mortality  $> 6\%$ ).

**Fig. 24. Prioritized interventions and intervention combinations for Country X: a) implementation scenario 1, and b) implementation scenario 2**

 This scenario is for illustrative purposes, and countries may have more or fewer interventions and strategies.

a) Intervention combinations for implementation scenario 1

1 CM, CHW, ITN or IRS, SMC, IPTp, vaccine	2 CM, CHW, ITN or IRS, SMC, IPTp, vaccine	3 CM, ITN or IRS, SMC, IPTp, vaccine	4 CM, ITN or IRS, SMC, IPTp, vaccine
5 CM, CHW, ITN or IRS, SMC, IPTp, vaccine	6 CM, CHW, ITN or IRS, SMC, IPTp, vaccine	7 CM, CHW, ITN or IRS, SMC, IPTp, vaccine	8 CM, CHW, ITN or IRS, SMC, IPTp, vaccine
9 CM, ITN, SMC, IPTp	10 CM, ITN, SMC, IPTp	11 CM, CHW, ITN, SMC, IPTp, vaccine	12 CM, CHW, ITN, SMC, IPTp, vaccine
13 CM, ITN, IPTp, PMC	14 CM, ITN, IPTp, PMC	15 CM, CHW, IPTp PMC, vaccine	16 CM, CHW, IPTp PMC, vaccine
17 CM, IPTp	18 CM, IPTp	19 CM, IPTp	20 CM, IPTp
21 CM, IPTp	22 CM, IPTp	23 CM, ITN, IPTp	24 CM, ITN, IPTp
25 CM, IPTp	26 CM, IPTp	27 CM, IPTp	28 CM, ITN, IPTp
29 CM, IPTp	30 CM, IPTp	31 CM, IPTp	32 CM, IPTp



The legend identifies the following intervention combinations:

- CM, CHW, ITN or IRS, SMC, IPTp, vaccine (Dark Blue)
- CM, ITN or IRS, SMC, IPTp, vaccine (Green)
- CM, ITN, SMC, IPTp (Red)
- CM, CHW, ITN, SMC, IPTp, vaccine (Light Blue)
- CM, ITN, IPTp, PMC (Grey)
- CM, CHW, IPTp PMC, vaccine (Yellow-Gold)
- CM, ITN, IPTp (Pink)

**Fig. 24. (continued)**

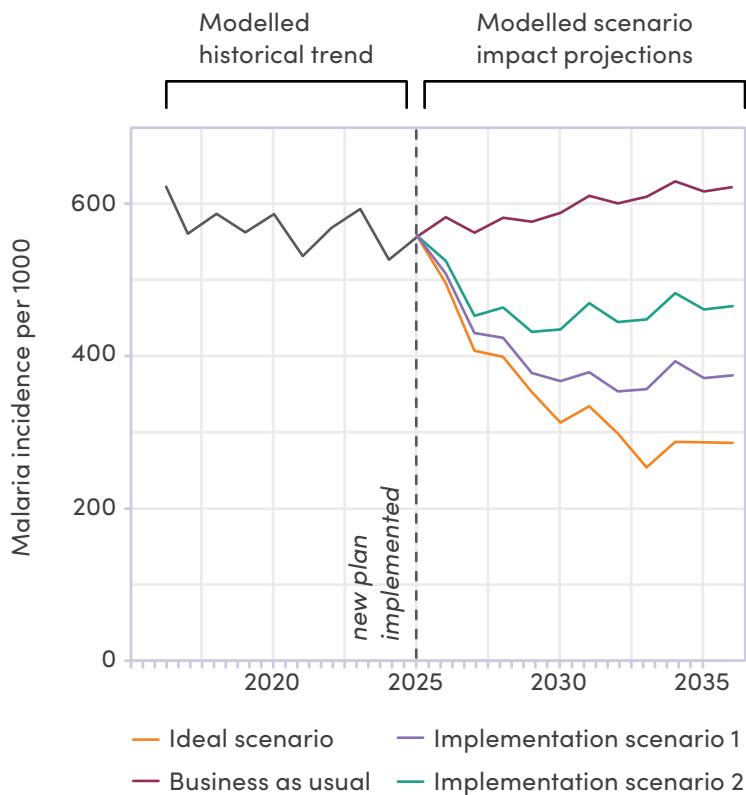
b) Intervention combinations for implementation scenario 2

1 CM, CHW, ITN SMC, IPTp, vaccine	2 CM, CHW, ITN SMC, IPTp, vaccine	3 CM, ITN, SMC, IPTp, vaccine	4 CM, ITN, SMC, IPTp, vaccine
5 CM, CHW, ITN, SMC, IPTp, vaccine	6 CM, CHW, ITN, SMC, IPTp, vaccine	7 CM, CHW, ITN, SMC, IPTp	8 CM, CHW, ITN, SMC, IPTp
9 CM, ITN, SMC, IPTp	10 CM, ITN, SMC, IPTp	11 CM, CHW, ITN, SMC, IPTp	12 CM, CHW, ITN, SMC, IPTp
13 CM, IPTp, PMC	14 CM, IPTp, PMC	15 CM, CHW, IPTp PMC	16 CM, CHW, IPTp PMC
17 CM	18 CM	19 CM	20 CM
21 CM	22 CM	23 CM	24 CM
25 CM	26 CM	27 CM	28 CM, ITN
29 CM	30 CM	31 CM	32 CM

CHW: community health worker; CM: case management; IPTp: intermittent preventive treatment in pregnancy; IRS: indoor residual spraying; ITN: insecticide-treated net; SMC: seasonal malaria chemoprevention.

The final three scenarios for analysis are the ideal scenario representing the combination of eligible interventions tailored to the subnational context (Fig. 23) and the two implementation scenarios with prioritized combinations of interventions (Fig. 24a and b). Mathematical models can be applied to assess the impact of these three scenarios on malaria burden against business as usual (Fig. 25).

**Fig. 25.** Country X impact scenario modelling based on intervention combinations for:  
 a) business as usual, b) the full NMSP (ideal scenario); c) implementation (prioritized) scenario 1; d) implementation (prioritized) scenario 2. Only the intervention combinations change but coverage target for an intervention, once selected, is assumed to remain the same across operational units. Scenarios are compared based on impact on case incidence.



NMSP: national malaria strategic plan; SNT: subnational tailoring.

### 2.3.3 Illustrative country example: strategic scenario for the NMSP and its optimization within available resources

The previously designed scenarios, including all eligible interventions and the two prioritized intervention combinations, should be costed. NMPs must then select the most impactful, evidence-based scenario that aligns with national goals while considering operational and financial feasibility (i.e. the strategic scenario). If the full set of eligible interventions (Fig. 23) is both cost-effective and impactful, it may be chosen. However, if the cost is prohibitively high or its implementation is not realistic, a prioritized scenario should be selected as the strategic scenario in the NMSP.

The strategic scenario in the NMSP should then be optimized for different resource envelopes, including the currently available funding and potential increases (or decreases) in funding. Various approaches can be used to optimize strategic scenarios within different budgets, such as scaling back or removing low-priority interventions based on previous implementation scenarios. In this example (Table 6), three scenarios are modelled and impact is measured using cases averted relative to business as usual, cumulatively over 5 years after the implementation of the new plan (2025–2030).

The 95% prediction interval is indicated in paratheses. Other methods may include reallocating resources using cost–effectiveness analyses and mathematical models, and addressing operational inefficiencies. Eventually the country will choose the most impactful scenario that fits the current envelope.

**Table 6. Country X impact scenario modelling based on intervention combinations for the full NMSP, implementation scenario 1, and implementation scenario 2**

	SNT scenario selected for NMSP (full strategic scenario), relative to BAU	Implementation scenario 1, relative to BAU (Box 4)	Implementation scenario 2, relative to BAU (Box 4)
<b>Children under 5 years</b>			
<b>Relative reduction in cases</b>	25% (21–29%)	21% (17–24%)	15% (12–18%)
<b>Cases averted (millions)</b>	5.0 (4.2–5.8)	4.2 (3.4–4.8)	3.0 (2.4–3.6)
<b>All ages</b>			
<b>Relative reduction in cases</b>	20% (17–23%)	18% (16–20%)	12% (10–14%)
<b>Cases averted (millions)</b>	8.0 (6.8–9.2)	7.2 (6.4–7.8)	4.8 (4.1–5.5)

BAU: business as usual; NMSP: national malaria strategic plan; SNT: subnational tailoring.

## Chapter 3

# Capacity-strengthening: practical considerations for SNT



Across malaria interventions, strategies and activities there is a need to ensure health workers at national and subnational levels have the capacity to deliver on their programmatic activities. Capacity development is a critical component of ensuring the success of SNT exercises, as it equips NMPs and their partners with the knowledge, skills and tools required to implement and sustain stratification and tailoring processes. To ensure these efforts are inclusive and equitable, capacity development should incorporate considerations such as gender-sensitive training content, equitable access to training opportunities (especially for women and marginalized groups), language- and literacy-appropriate materials, and awareness of social and structural barriers that affect service delivery and access for vulnerable populations.

WHO has developed guidelines for health workforce development (55) that can be adapted by NMPs to ensure the malaria human resource capacity in the country is strengthened. While the costs required to do this are usually not entirely from the direct malaria budget, it should not be treated as an afterthought during the SNT process. Capacity development for SNT must be closely aligned with the technical, analytical and operational needs of the exercise, addressing gaps in data analysis, decision-making and implementation.

Capacity development for SNT has several objectives.

- Build technical expertise. Enhance the ability of national and subnational teams – including both trainers and implementers – to conduct stratification, analyse data, and tailor interventions based on the malaria burden.
- Strengthen data management and analysis skills. Equip teams with the skills to collect, clean, analyse, and visualize data required for stratification and tailoring.
- Enhance data-driven decision-making and prioritization. Build capacity to apply evidence-based decision-making at all levels of the health system, optimize resources, and prioritize interventions within the SNT framework.
- Develop implementation and monitoring competencies. Strengthen the ability to plan, execute, and monitor tailored interventions effectively at the subnational level.
- Build awareness and skills to identify and address gender- and equity-related barriers in malaria service delivery, ensure inclusive participation in decision-making, and tailor interventions to meet the needs of underserved and vulnerable populations.

Sustainability and long-term impact of capacity development for SNT require institutionalizing training efforts within existing health systems and educational structures, especially at local levels. This involves embedding SNT-related skills into pre-service and in-service training programmes for health professionals and integrating malaria-focused modules into public health curricula at universities and training colleges. These programmes should be designed to promote equitable access, actively include women and marginalized groups, and address barriers that limit participation or advancement. Table 7 describes skills, tools and training examples relevant to key focus areas for SNT capacity-building.

**Table 7.** SNT capacity-building focus areas

Focus area	Skills	Tools	Training examples
<b>Data science</b>	Data cleaning, geospatial analysis, epidemiological modelling and identification of inequities across vulnerable groups	GIS software (QGIS, ArcGIS), statistical platforms (R, Python), data visualization tools	Curriculum subjects such as "Data science for malaria" that include content on data assembly (including guidance for disaggregating data, e.g. by age and sex) and management, analysis (e.g. WHO Academy (23)), and action-focused interpretations
<b>Digital tools</b>	Leveraging digital platforms for intervention targeting and delivery	DHIS2 for timely monitoring and decision-making; digital microplanning templates	Workshops on using digital tools for intervention mapping and monitoring, tailored for both programme managers and front-line users
<b>Scenario planning and costing</b>	Cost-effectiveness analysis, budget forecasting, optimization under resource constraints	Cost-effectiveness and costing templates	Scenario-based exercises to evaluate the impact and cost-effectiveness of tailored intervention combinations; scenarios should include/prioritize vulnerable populations
<b>Monitoring, evaluation and learning</b>	Designing monitoring, evaluation and learning frameworks, setting indicators, conducting adaptive management and integrating GED-sensitive indicators	Monitoring and evaluation templates, dashboard design, data feedback loops	Hands-on training in developing and implementing monitoring, evaluation and learning systems specific to SNT exercises
<b>Stakeholder management</b>	Communicating evidence-based results, mobilizing resources, fostering multisectoral collaboration and engaging diverse community voices including women and marginalized populations	Stakeholder engagement frameworks, advocacy planning templates	Advocacy workshops and simulation exercises for effectively engaging stakeholders at all levels – from CHWs engaging communities to national staff engaging donors
<b>Programmatic and leadership</b>	Operational planning, implementation management, team coordination, leadership development and fostering inclusive leadership and team diversity	Leadership development frameworks, operational planning tools	Leadership and behavioural change training, focusing on ensuring successful execution, equity and sustainability of SNT strategies

CHW: community health worker; GED: gender, equality and diversity; GIS: geographic information system;  
SNT: subnational tailoring.

Operational research should be conducted to evaluate the effectiveness of capacity-building efforts and refine training methods based on the findings. Retention strategies, such as mentorship, career development opportunities, and partnerships with academic institutions, are crucial to maintaining a skilled workforce. Mentorship and advancement opportunities should be inclusive and support underrepresented groups in leadership pathways. These efforts ensure that capacity development is continuous, adaptable, and capable of supporting ongoing stratification and tailoring needs for malaria control and elimination.

SNT-specific capacity development should deliver a structured competency framework, training resources and tools, equipping teams to execute stratification and tailoring effectively. These outputs ensure skilled personnel, actionable malaria control plans, and institutionalized processes for adapting interventions to local contexts. Furthermore, capacity-building must be system-wide – empowering not only those who deliver training but also those at the point of care who apply it – ensuring alignment, ownership and lasting impact across all tiers of the malaria response.

# Chapter 4

## Conclusion



SNT supports NMPs in making better use of available data to develop strategic, prioritized and context-specific responses to malaria across the malaria transmission continuum. Recognizing the geographical and seasonal heterogeneity of malaria transmission, the manual provides a practical, step-by-step approach that aligns with national strategic planning and implementation cycles, and emphasizes the use of epidemiological and intervention surveillance data and analytical methods, such as modelling and cost-effectiveness analyses. This process enables NMPs to identify priority areas, adapt interventions to local needs, and allocate, advocate for and mobilize resources more effectively.

The SNT process is inherently iterative and should be adapted to align with country goals and priority questions. Ten key implementation steps are proposed in the manual; however, the process is not linear and should be applied flexibly, based on the specific programmatic questions being addressed and timelines within which decisions are needed. To implement SNT successfully, NMPs are encouraged to lead and institutionalize the process within existing planning and implementation mechanisms. This includes establishing multidisciplinary SNT teams who collaborate with different units in and outside the ministry of health, coordinate across national and subnational levels, and ensure the involvement of key technical partners. Strengthening capacity in data analysis, stratification and programme design – particularly at subnational levels – is essential to ensure the sustainability and impact of SNT at all relevant levels of the system.

NMPs should commit to reviewing and updating their tailored intervention strategies as new data, evidence and guidelines become available and local contexts evolve. They should document learnings for future SNT iterations. Countries can leverage cross-country platforms, such as the RBM Partnership to End Malaria's Surveillance, Monitoring and Evaluation Working Group, to exchange experiences and share lessons learned. They are also encouraged to publish their reports publicly to promote transparency, foster collaboration and contribute to the global knowledge base on malaria surveillance and data-informed programme planning and implementation.

NMPs are encouraged to refer to WHO guidance, including the consolidated malaria, intervention prioritization, surveillance, and strategic planning guidelines, to ensure coherence across planning, implementation, and monitoring efforts.

# References<sup>1</sup>

1. Global technical strategy for malaria 2016–2030, 2021 update. Geneva: World Health Organization; 2021 (<https://iris.who.int/handle/10665/342995>).
2. WHO guidelines for malaria [website]. World Health Organization; 2024 (<https://app.magicapp.org/#/guideline/LwRMXj>).
3. Guiding principles for prioritizing malaria interventions in resource-constrained country contexts to achieve maximum impact. Geneva: World Health Organization; 2024 (<https://doi.org/10.2471/B09044>).
4. Universal health coverage [website]. World Health Organization; 2024 (<https://www.who.int/health-topics/universal-health-coverage>).
5. Baltussen R, Jansen M, Mikkelsen E, Tromp N, Hontelez J, Bijlmakers L et al. Priority setting for universal health coverage: we need evidence-informed deliberative processes, not just more evidence on cost-effectiveness. *Int J Health Policy Manag.* 2016;5(11):615–8 (<https://doi.org/10.15171/ijhpm.2016.83>).
6. From value for money to value-based health services: a twenty-first century shift – WHO policy brief. Geneva: World Health Organization; 2021 (<https://iris.who.int/handle/10665/340724>).
7. Paris declaration on aid effectiveness Paris: Organisation for Economic Co-operation and Development; 2005 ([https://www.oecd.org/en/publications/paris-declaration-on-aid-effectiveness\\_9789264098084-en.html](https://www.oecd.org/en/publications/paris-declaration-on-aid-effectiveness_9789264098084-en.html)).
8. The Accra Agenda for Action. Paris: Organisation for Economic Co-operation and Development; 2008 ([https://www.oecd.org/en/publications/accra-agenda-for-action\\_9789264098107-en.html](https://www.oecd.org/en/publications/accra-agenda-for-action_9789264098107-en.html)).
9. User guide for the malaria strategic and operational plan costing tool. Brazzaville: World Health Organization Regional Office for Africa; 2019 (<https://iris.who.int/handle/10665/325014>).
10. Practical manual for malaria programme review and malaria strategic plan midterm review. Brazzaville: World Health Organization Regional Office for Africa; 2019 (<https://iris.who.int/handle/10665/325003>).
11. Manual for developing national malaria strategic plans. Brazzaville: World Health Organization Regional Office for Africa; 2019 (<https://iris.who.int/handle/10665/324995>).
12. Report from the WHO Global Malaria Programme, Malaria Policy Advisory Group meeting, 8–10 April. Geneva: World Health Organization; 2025 (<https://cdn.who.int/media/docs/default-source/malaria/mpac-documentation/mpag-documentation-day-1-april-2025.pdf>).

<sup>1</sup> All references were accessed on 2 June 2025.

13. Malaria Surveillance Assessment Toolkit [website]. World Health Organization; 2024 (<https://malsurtoolkit.who.int/>).
14. WHO Malaria Toolkit app [online application]. World Health Organization Global Malaria Programme; 2024 (<https://www.who.int/teams/global-malaria-programme/malaria-toolkit-app>).
15. Kang SY, Amratia P, Dunn J, Vilay P, Connell M, Symons T et al. Fine-scale maps of malaria incidence to inform risk stratification in Laos. *Malar J.* 2024;23:196 (<https://doi.org/10.1186/s12936-024-05007-9>).
16. Thawer SG, Chacky F, Runge M, Reaves E, Mandike R, Lazaro S et al. Sub-national stratification of malaria risk in mainland Tanzania: a simplified assembly of survey and routine data. *Malar J.* 2020;19:1–13 (<https://doi.org/10.1186/s12936-020-03250-4>).
17. Malaria surveillance, monitoring and evaluation: a reference manual, second edition. Geneva: World Health Organization; 2025 (<https://iris.who.int/handle/10665/381864>).
18. Malaria Surveillance Assessment Toolkit: implementation reference guide. Geneva: World Health Organization; 2022 (<https://iris.who.int/handle/10665/361178>). Second edition in press.
19. Guidance on establishing a national malaria data repository. Geneva: World Health Organization; 2025 (<https://www.who.int/publications/m/item/guidance-on-establishing-a-national-malaria-data-repository>).
20. Ozodiegwu ID, Ambrose M, Galatas B, Runge M, Nandi A, Okuneye K et al. Application of mathematical modelling to inform national malaria intervention planning in Nigeria. *Malar J.* 2023;22(1):137 (<https://doi.org/10.1186/s12936-023-04563-w>).
21. Mulugeta A, Assefa A, Eshetie A, Asmare B, Birhanie M, Gelaw Y. Six-year trend analysis of malaria prevalence at University of Gondar Specialized Referral Hospital, Northwest Ethiopia, from 2014 to 2019. *Sci Rep.* 2022;12(1):1411 (<https://doi.org/10.1038/s41598-022-05530-2>).
22. Malaria: harnessing the power of routine health facility data [Online learning ]. WHO Academy; 2024 ([https://whoacademy.org/coursewares/course-v1:WHOA+0040\\_ML\\_EN+2024?source=edX](https://whoacademy.org/coursewares/course-v1:WHOA+0040_ML_EN+2024?source=edX)).
23. Galatas B, Saúte F, Martí-Soler H, Guinovart C, Nhamussua L, Simone W et al. A multiphase program for malaria elimination in southern Mozambique (the Magude project): A before-after study. *PLoS Med.* 2020;17(8):e1003227 (<https://doi.org/10.1371/journal.pmed.1003227>).
24. Garcia KKS, Soremekun S, Bottomley C, Abrahão AA, de Miranda CB, Drakeley C et al. Assessing the impact of the “malaria supporters project” intervention to malaria control in the Brazilian Amazon: an interrupted time-series analysis. *Malar J.* 2023;22:275 (<https://doi.org/10.1186/s12936-023-04706-z>).

- 25.** Kleinschmidt I, Bagayoko M, Clarke GPY, Craig MH, Le Sueur D. A spatial statistical approach to malaria mapping. *Int J Epidemiol.* 2000;29(2):355–61 (<https://doi.org/10.1093/ije/29.2.355>).
- 26.** Gemperli A, Sogoba N, Fondjo E, Mabaso M, Bagayoko M, Briët OJT et al. Mapping malaria transmission in West and Central Africa. *Trop Med Int Health.* 2006;11(7):1032–46 (<https://doi.org/10.1111/j.1365-3156.2006.01640.x>).
- 27.** Lysenko A, Beljaev A. An analysis of the geographical distribution of Plasmodium ovale. *Bull World Health Organ.* 1969;40(3):383–94 (<https://pmc.ncbi.nlm.nih.gov/articles/PMC2554635/>).
- 28.** Sturrock HJ, Cohen JM, Keil P, Tatem AJ, Le Menach A, Ntshalintshali NE et al. Fine-scale malaria risk mapping from routine aggregated case data. *Malar J.* 2014;13:421 (<https://doi.org/10.1186/1475-2875-13-421>).
- 29.** Vilay P, Dunn JC, Sichanthongthip O, Reyburn R, Butphomvihane P, Phiphakavong V et al. Malaria risk stratification in Lao PDR guides program planning in an elimination setting. *Sci Rep.* 2024;14:1709 (<https://doi.org/10.1038/s41598-024-52115-2>).
- 30.** Thwing J, Camara A, Candrinho B, Zulliger R, Colborn J, Painter J et al. A Robust Estimator of Malaria Incidence from Routine Health Facility Data. *Am J Trop Med Hyg.* 2020;102(4):811–20 (<https://doi.org/10.4269/ajtmh.19-0600>).
- 31.** Odhiambo J, Kalinda CM, PM Snow, RW, Sartorius B. Spatial and spatio-temporal methods for mapping malaria risk: a systematic review. *BMJ Glob Health.* 2020;5(10):e003547 (<https://doi.org/10.1136/bmjgh-2020-002919>).
- 32.** Malaria Atlas Project [website]. Malaria Atlas Project; 2024 (<https://malariaatlas.org/>).
- 33.** Mayor A, Menéndez C, Walker P. Targeting pregnant women for malaria surveillance. *Trends Parasitol.* 2019;35(9):677–86 (<https://doi.org/10.1016/j.pt.2019.07.005>).
- 34.** World Health Organization Global Malaria Programme. Tools for monitoring antimalarial drug efficacy [website]. World Health Organization; 2025 (<https://www.who.int/teams/global-malaria-programme/case-management/drug-efficacy-and-resistance/tools-for-monitoring-antimalarial-drug-efficacy>).
- 35.** Service availability and readiness assessment (SARA): an annual monitoring system for service delivery – reference manual, version 2.2, revised July 2015. Geneva: World Health Organization; 2014 (<https://iris.who.int/handle/10665/149025>).
- 36.** Multiple first-line therapies as part of the response to antimalarial drug resistance: an implementation guide. Geneva: World Health Organization; 2024 (<https://iris.who.int/handle/10665/379576>).
- 37.** Strategy to respond to antimalarial drug resistance in Africa. Geneva: World Health Organization; 2022 (<https://iris.who.int/handle/10665/364531>).
- 38.** Conditions for deployment of mosquito nets treated with a pyrethroid and piperonyl butoxide: recommendations. Geneva: World Health Organization; 2017 (<https://iris.who.int/handle/10665/258939>).

- 39.** Carter R, Karunaweera ND. The role of improved housing and living environments in malaria control and elimination. *Malar J*. 2020;19:385 (<https://doi.org/10.1186/s12936-020-03450-y>).
- 40.** Operational manual on indoor residual spraying: control of vectors of malaria, Aedes-borne diseases, Chagas disease, leishmaniasis and lymphatic filariasis. Geneva: World Health Organization; 2023 (<https://iris.who.int/handle/10665/375978>).
- 41.** Larval source management: a supplementary malaria vector control measure – an operational manual. Geneva: World Health Organization; 2013 (<https://iris.who.int/handle/10665/85379>).
- 42.** Community deployment of intermittent preventive treatment of malaria in pregnancy with sulfadoxine-pyrimethamine: a field guide. Geneva: World Health Organization; 2024 (<https://iris.who.int/handle/10665/375714>).
- 43.** Intermittent preventive treatment for infants using sulfadoxine-pyrimethamine (SP-IPTi) for malaria control in Africa: implementation field guide. Geneva: World Health Organization; 2011 (<https://iris.who.int/handle/10665/70736>).
- 44.** Seasonal malaria chemoprevention with sulfadoxine-pyrimethamine plus amodiaquine in children: a field guide, 2nd ed. Geneva: World Health Organization; 2023 (<https://iris.who.int/handle/10665/368123>).
- 45.** Malaria chemoprevention efficacy study protocol. Geneva: World Health Organization; 2022 (<https://iris.who.int/handle/10665/360908>).
- 46.** Malaria vaccine implementation programme [website]. World Health Organization; 2024 (<https://www.who.int/initiatives/malaria-vaccine-implementation-programme>).
- 47.** World Health Organization. Malaria vaccines: WHO position paper. *Weekly Epidemiological Record*. 2024;99(19):225–48 (<https://iris.who.int/handle/10665/376739>).
- 48.** Guide to introducing malaria vaccines into national immunization programmes. Geneva: World Health Organization; 2025 (<https://www.technet-21.org/en/resources/guidance/guide-for-introducing-a-malaria-vaccine-into-national-immunization-programmes>).
- 49.** Mass drug administration for falciparum malaria: a practical field manual. Geneva: World Health Organization; 2017 (<https://iris.who.int/handle/10665/259367>).
- 50.** Smith T, Maire N, Ross A, Penny M, Chitnis N, Schapira A et al. Towards a comprehensive simulation model of malaria epidemiology and control. *Parasitology*. 2008;135(13):1507–16 (<https://doi.org/10.1017/s0031182008000371>).
- 51.** Champagne C, Gerhards M, Lana JT, Le Menach A, Pothin E. Quantifying the impact of interventions against Plasmodium vivax: a model for country-specific use. *Epidemics*. 2024;46:100747 (<https://doi.org/10.1016/j.epidem.2024.100747>).
- 52.** World Health Organization, United Nations Children's Fund. Institutionalizing integrated community case management (iCCM) to end preventable child deaths: a technical consultation and country action planning, 22–26 July 2019, Addis Ababa. Geneva: World Health Organization; 2020 (<https://iris.who.int/handle/10665/333541>).

**53.** Monroe A, Moore S, Okumu F, Kiware S, Lobo NF, Koenker H et al. Methods and indicators for measuring patterns of human exposure to malaria vectors. *Malar J*. 2020;19:207 (<https://doi.org/10.1186/s12936-020-03271-z>).

**54.** Global framework for the response to malaria in urban areas. Geneva: World Health Organization; 2022 (<https://iris.who.int/handle/10665/363899>).

**55.** WHO guideline on health workforce development, attraction, recruitment and retention in rural and remote areas. Geneva: World Health Organization; 2021 (<https://iris.who.int/handle/10665/341139>).

# Annexes

**Annex 1. SNT team technical lead terms of reference**

**Annex 2. Checklist to guide data collection**

**Annex 3. The malaria transmission continuum**

**Annex 4. Estimating effective coverage of malaria interventions**

**Annex 5. Stratification of malaria risk and interventions**

**Annex 6. Practical considerations for tailoring malaria interventions and strategies**

**Annex 7. Mathematical modelling**

**Annex 8. SNT costing support**

**Annex 9. Cost-effectiveness for decision-making**

**Annex 10. Surveillance, monitoring and evaluation**

# Annex 1. SNT team technical lead terms of reference

Terms of reference should be established for each role working on the SNT team.

Fig. A1.1 is an example of terms of reference for the team technical lead. Italic text shows where the NMP should insert its own information into the example.

**Fig. A1.1. Example terms of reference for SNT consultancy for an NMP**

## Terms of reference

### Consultancy

#### 1. Purpose of the consultancy

The *Insert name of NMP* requires an experienced epidemiologist to perform a subnational tailoring of malaria interventions analysis in *country*. The selected candidate will work under the management of the *Insert name of NMP Manager*.

#### 2. Background

*Insert country-specific background.*

A key pillar of the *Global Technical Strategy for Malaria 2016–2030* is enhanced surveillance and the use of local data for decision-making by malaria programmes and partners. There are five essential steps involved in the development and monitoring of prioritized malaria control and elimination programmes:

- development of a national, regional and global partnership to lead the process for the subnational tailoring of malaria interventions;
- stratification of malaria risk and its determinants – natural, systemic and anthropogenic – to inform intervention targeting criteria;
- development of an optimal national strategic plan that defines the combinations of interventions and strategies needed to optimize malaria control and elimination in a country;
- rational prioritization of investments to maximize impact, while ensuring value-based health service delivery, when the resources are insufficient to provide the optimal intervention combinations; and
- monitoring the impact of the deployed intervention combinations so that the effectiveness of the response can be improved over time.

This position is intended to provide support to the National Malaria Programme on each of the abovementioned steps with the aim of adapting World Health Organization recommendations on malaria interventions and strategies to implement evidence-informed, locally owned strategic plans.

### 3. Planned timelines (subject to confirmation)

Start date: dd Month yyyy

End date: dd Month yyyy

### 4. Work to be performed

- Oversee data assembly together with the surveillance monitoring and evaluation lead in the National Malaria Programme.
- Support the National Malaria Programme in responding to data collection, review, validation, and analysis needs to inform the subnational tailoring process.
- Develop in-country capacity to ensure sustainability of the subnational tailoring process.
- Work with World Health Organization and other analytical partners on the stratification and tailoring of interventions analysis.
- Participate in all convenings related to subnational tailoring to ensure a transparent review of all analytical products produced for decision-making.
- Communicate analysis products and coordinate feedback from local or international analysis or modelling groups engaged in the subnational tailoring process.

### 5. Specific requirements

- **Qualifications required.** Master of Epidemiology, Public Health or similar, with a strong analytical background. A PhD in relevant disciplines is considered an advantage.
- **Experience required.** Experience working in malaria endemic countries. Proven experience with routine/programmatic data collection, management and analysis, ideally in the area of malaria or other vector-borne diseases.
- **Skills/technical skills and knowledge.** Good knowledge of analysis and statistical software (e.g. SPSS, Stata), database management systems (Microsoft Access, DHIS2). Experience working with national malaria programmes and/or surveillance or monitoring and evaluation units within the ministry of health.
- **Language requirements.** *Insert as applicable.*

### 6. Place of assignment

*Insert place of assignment.*

## Annex 2. Checklist to guide data collection

Countries should customize the checklist provided in Table A2.1 for their country context and reference the WHO manual on malaria surveillance, monitoring and evaluation (1) and the list of core indicators for surveillance, monitoring and evaluation (2) for further indicators information (e.g. numerator and denominators, transmission settings where the indicator is relevant).

**Table A2.1. Data collection checklist**

Data/indicator	Description and data sources
<b>Epidemiological</b>	
<input type="checkbox"/> Prevalence	Data may be: <ul style="list-style-type: none"> <li>• community-based malaria infection prevalence estimates; or</li> <li>• spatio-temporal estimates of standardized malaria prevalence.</li> </ul> Data can be obtained from: <ul style="list-style-type: none"> <li>• DHS, MIS (3) or similar survey data available at the country level;<sup>a</sup></li> <li>• parasite surveys conducted in select sites throughout the country as part of research-specific activity; and</li> <li>• estimations produced by spatio-temporal models by local, regional or global universities or research groups such as the Malaria Atlas Project (4).</li> </ul>
<input type="checkbox"/> All-cause outpatients	Routine outpatient and inpatient data
<input type="checkbox"/> Suspected malaria cases	Ideally obtain monthly health-facility level data reported for the past 10 years. All variables should include all ages and age-specific disaggregation (< 5 and ≥ 5, or other if applicable), and sex and other relevant disaggregations.
<input type="checkbox"/> Tested (RDT or microscopy)	
<input type="checkbox"/> Confirmed (RDT or microscopy)	
<input type="checkbox"/> Presumed malaria cases	
<input type="checkbox"/> Patients treated with an antimalarial	
<input type="checkbox"/> Uncomplicated malaria cases	
<input type="checkbox"/> Severe malaria cases	
<input type="checkbox"/> All-cause inpatients	
<input type="checkbox"/> Malaria-associated inpatients	
<input type="checkbox"/> All-cause mortality	Mortality data can be obtained from: <ul style="list-style-type: none"> <li>• Health-facility level data</li> <li>• other child mortality estimation studies; and</li> <li>• spatio-temporal estimates available from local, regional or international organizations such as IMHE (5).</li> </ul>
<input type="checkbox"/> Malaria-associated mortality	

<b>Data/indicator</b>	<b>Description and data sources</b>
<input type="checkbox"/> Parasite species distribution In elimination settings, also obtain: <ul style="list-style-type: none"> <li>• number of confirmed cases;</li> <li>• distribution of cases; and</li> <li>• classification of cases.</li> </ul>	Case notification and case investigation data
<b>Entomological</b>	
<input type="checkbox"/> Vector abundance (e.g. percentage of each anopheline species collected at a specific site and a specific point in time)	Sentinel sites/research studies Other sources include the Malaria Atlas Project (4)
<input type="checkbox"/> Vector behaviour data (e.g. biting times)	Sentinel sites/research studies
<input type="checkbox"/> Insecticide resistance	Species-specific mortality 24 hours after exposure to different insecticides per site
<input type="checkbox"/> GPS coordinates of the entomological surveillance/ sentinel sites	Sentinel sites/research studies
<input type="checkbox"/> Net durability	Net durability studies
<input type="checkbox"/> Quality and retention of ITNs after their distribution	Household surveys
<input type="checkbox"/> Residual efficacy of IRS	Efficacy studies
<b>Interventions</b>	
<input type="checkbox"/> Number of women and girls who attended the ANC1, 2, 3, 4+ visits	Routine intervention surveillance data. This information should be at the same level and for the same period as that provided for the routine patient data to enable better understanding of the delivery of IPTp and routine distributions of ITNs.
<input type="checkbox"/> Number of women and girls who received IPTp1, 2, 3, 4+	
<input type="checkbox"/> Number of ITNs distributed through ANC	District-level information on the implementation of any of the following interventions if applicable: mass ITN campaigns, IRS, SMC or iCCM. This information should go as far back in time as possible.
<input type="checkbox"/> Number of children immunized with DTP2/Penta2, DTP3/Penta3, measles vaccine, malaria vaccine	
<input type="checkbox"/> Number of children who received PMC	
<input type="checkbox"/> Number of ITNs distributed through the EPI programmes and other routine programmes such as school distributions	
Variables for mass ITN campaigns: <input type="checkbox"/>	Routine intervention surveillance data and/or campaign implementation data
<input type="checkbox"/> month, or at least year, when each district received the mass campaign;	District-level information on the implementation of any of the following interventions if applicable: mass ITN campaigns, IRS, SMC or iCCM. This information should also go as far back in time as possible.
<input type="checkbox"/> target population and nets planned per district; and	
<input type="checkbox"/> number of ITNs distributed per district.	

<b>Data/indicator</b>	<b>Description and data sources</b>
<input type="checkbox"/> ITN variables from household surveys: household coverage and access to ITNs	Community-based intervention coverage and usage
<input type="checkbox"/> ITN variables from household surveys: individual use of ITNs the previous nights	
IRS: <input type="checkbox"/> month when the district received IRS; <input type="checkbox"/> target number of households; and households sprayed.	
<input type="checkbox"/> IRS variables from household surveys: households sprayed with IRS in the previous 12 months	
SMC: <input type="checkbox"/> target number of children; <input type="checkbox"/> number of doses distributed (per round or mean of all rounds); and <input type="checkbox"/> coverage per round (or mean of all rounds).	Routine intervention surveillance and/or campaign implementation data. Additional information available for the specific context (number of children excluded, number of children referred, number of children tested and confirmed with an RDT, number of children with adverse events, etc.).
iCCMs: <input type="checkbox"/> number of CHWs available per district per year; and <input type="checkbox"/> geolocation of the CHWs.	Routine intervention surveillance data. Any additional forms of distribution will also be important to report (malaria prevention among refugees or internally displaced people, etc.).
<input type="checkbox"/> Efficacy	Efficacy studies for treatment (e.g. therapeutic efficacy studies) and research studies
<input type="checkbox"/> Resistance	Molecular surveillance and research studies
<b>Health system readiness</b>	
<input type="checkbox"/> Access-to-care metrics	This can be obtained through spatial analysis using tools such as AccessMod (5) or similar approaches, or simplified analysis where the population living inside or outside of a 5 km radius from the nearest health facility is estimated.
<input type="checkbox"/> Care-seeking behaviour for fever, from the public, private or other sectors, as well as the proportion of individuals who do not seek care	Community-based intervention coverage and usage. This information is usually available from DHS, MIS or other surveys, generally conducted at regional level and at 2–3-year intervals. Data and reports can be obtained directly from the DHS website (3). Some required indicators may not always be provided in the report and simple analysis of the survey data will be needed. Other information may be available from locally conducted research studies evaluating one or more of these indicators.
<input type="checkbox"/> Proportion of individuals who sought care who were diagnosed and treated for malaria	Community-based intervention coverage and usage

<b>Data/indicator</b>	<b>Description and data sources</b>
<input type="checkbox"/> Presence of <i>pfhrp2/pfhrp3</i> deletions	This information is obtained through the calculation of indicators using routine data that can inform about the quality of care provided in an area (i.e. testing rates, treatment rates, proportion of malaria outpatients with severe malaria, hospital mortality ratios, etc.). Publicly available databases from the latest service availability and readiness assessments conducted in-country.
<input type="checkbox"/> Treatment efficacy measurements	
<input type="checkbox"/> Information on the available human and in-kind infrastructure per health facility	
<input type="checkbox"/> Stock outs and stock management information (qualitative or quantitative) that could explain issues with stock availability	
<input type="checkbox"/> Specific research studies where the quality of care in health facilities has been evaluated	
<input type="checkbox"/> Stock information: RDT, ACT and artesunate availability per month	Routine outpatient and inpatient data
<input type="checkbox"/> Data quality assessments that evaluated indicators such as 1) completeness, 2) timeliness, and 3) accuracy of the data available	Quality of the surveillance system can be understood using results from surveillance system assessments and data quality reviews.
<input type="checkbox"/> Qualitative information obtained for the understanding of the main limitations that affect surveillance systems in a given area (connectivity, capacity, supervision, availability of materials and tools, lack of time, etc.).	
<b>Ecological</b>	
<input type="checkbox"/> Rainfall	Environmental and climatic data from various data sources, such as:
<input type="checkbox"/> Temperature (minimum, mean, maximum)	<ul style="list-style-type: none"> <li>• weather stations in the country; and</li> <li>• satellite imagery (CHIRPS, ERA5, MODIS, etc.).</li> </ul>
<input type="checkbox"/> Humidity	
<input type="checkbox"/> Enhanced vegetation index	NMPs should specify if they prefer a particular source.
<b>Other</b>	
<input type="checkbox"/> Insecurity areas	
<input type="checkbox"/> Areas with refugees or internally displaced people	Other relevant data that the country considers relevant to understand the malaria situation in-country, such as refugee and population displacement records (e.g. OCHA) and labour surveys.
<input type="checkbox"/> Community behavioural data (e.g. mobility and migration, forest goers)	
<input type="checkbox"/> Agriculture areas	

Data/indicator	Description and data sources
<input type="checkbox"/> Country shapefiles	Country shapefiles <ul style="list-style-type: none"> <li>• Crucial for creating accurate maps, the shapefiles should contain first (region) and second (districts) administrative borders.</li> <li>• The list of districts that appears in the shapefiles should match the names of the districts that will appear in all the other datasets.</li> </ul>
<input type="checkbox"/> Master list of geocoded health facilities	A database with the GPS coordinates of the functional health facilities through time, categorized by type (e.g. health post, hospital, private)
<input type="checkbox"/> Population estimates	Official district-level (or health facility catchment-level) population estimates per year (e.g. projected population surveys)
<input type="checkbox"/> Costing data	See Annex 8: SNT costing support

ACT: artemisinin-based combination therapy; ANC: antenatal care; CHIRPS: Climate Hazards Center InfraRed Precipitation with Station; CHW: community health worker; DHS: Demographic and Health Surveys Program; DTP2: second dose of the diphtheria, tetanus, pertussis vaccine; DTP3: third dose of the diphtheria, tetanus, pertussis vaccine; EPI: Essential Programme on Immunization; ERA5: ECMWF Reanalysis 5th Generation; GPS: Global Positioning System; iCCM: integrated community case management; IMHE: Institute for Health Metrics and Evaluation; IPTp: intermittent preventive treatment in pregnancy; IRS: indoor residual spraying; ITN: insecticide-treated net; MIS: Malaria Indicator Survey; MODIS: Moderate Resolution Imaging Spectroradiometer; OCHA: United Nations Office for the Coordination of Humanitarian Affairs; Penta2: second dose of the pentavalent vaccine; Penta3: third dose of the pentavalent vaccine; PMC: perennial malaria chemoprevention ; RDT: rapid diagnostic test; SMC: seasonal malaria chemoprevention.

Note: <sup>a</sup> The United States Agency for International Development DHS (<https://dhsprogram.com/>) has conducted more than 400 surveys, including the MIS, in over 90 countries.

## References<sup>1</sup>

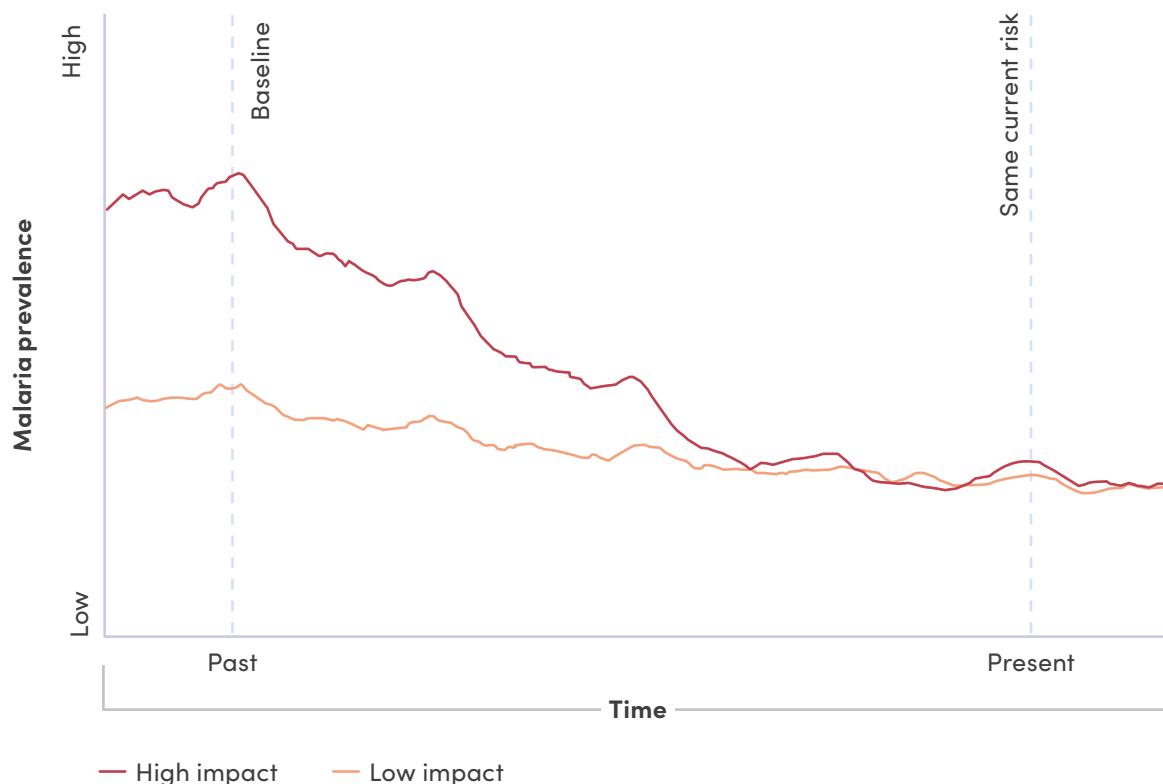
1. Malaria surveillance, monitoring and evaluation: a reference manual, second edition. Geneva: World Health Organization; 2025 (<https://iris.who.int/handle/10665/381864>).
2. Core indicators for surveillance, monitoring and evaluation. Geneva: World Health Organization; 2025 (<https://www.who.int/publications/m/item/core-indicators-for-malaria-surveillance-monitoring-and-evaluation>).
3. The DHS Program [website]. United States Agency for International Development; 2024 (<https://dhsprogram.com/>).
4. Malaria Atlas Project [website]. Malaria Atlas Project; 2024 (<https://malariaatlas.org/>).
5. Global Burden of Disease Study 2021 (GBD 2021). Causes of death or injury, risk factor, etiology, impairment, summary exposure value (SEV), healthy life expectancy (HALE), injuries by nature, all-cause mortality, fertility, population [website]. Institute for Health Metrics and Evaluation; 2021 (<https://vizhub.healthdata.org/gbd-results/>).
6. AccessMod [website]. World Health Organization; 2023 (<https://www.accessmod.org/>).

<sup>1</sup> All references were accessed on 11 June 2025.

# Annex 3. The malaria transmission continuum

The starting point for decisions on SNT of strategies and interventions for malaria control and elimination is an understanding of the malaria transmission intensity and burden at each place – at present and at a defined baseline. These inform the change over time, the type and scale of interventions needed and the adaptation of the response as the epidemiology changes. Two places with the same level of current risk could have begun with different baselines due to variation in the effectiveness or coverage of interventions and the effect of extrinsic factors (Fig. A3.1).

**Fig. A3.1.** In the absence of a baseline, current levels of risk tell us little about the ongoing effectiveness of interventions



Malaria transmission dynamics, shaped by interactions between the vector, human and parasite, guide decisions related to SNT. Key points include:

- **baseline and current transmission levels.** Historical and current transmission data reveal malaria receptivity and the effects of interventions. Declining transmission may suggest it would be appropriate to scale back efforts, whereas minimal change despite intervention scaling indicates potential inefficacy or obstructive factors. Decisions should not rely solely on current transmission or malaria burden.

- **intervention impact determinants.** The effectiveness of interventions such as ITNs and IRS depends on vector behaviour, and greater impact is seen in areas where vectors primarily bite and rest indoors. SMC is most effective in highly seasonal, moderate to high transmission settings that experience significant numbers of severe malaria cases in young children. Intervention success also depends on case management quality, resistance levels and disruptions from emergencies.
- **effectiveness and coverage.** Sustained intervention efficacy and the proportion of the population protected are critical. Lower-efficacy interventions with slower effectiveness decay can achieve greater overall impact than high-efficacy interventions with rapid decay. Sustaining high coverage is essential for success.

## A3.1 Key malaria transmission indicators and thresholds

Robust metrics and indicators are essential to guide decision-making and provide an understanding of past and current status, including what has caused any changes between the past and now. These metrics provide valuable insights into various aspects of the malaria transmission cycle, helping to measure progress, assess the impact of interventions, and identify areas requiring further attention. Different metrics correspond to various aspects of the transmission cycle and fluctuate at different rates (Table A3.1). Within the same setting, each metric may respond differently to any particular intervention.

**Table A3.1. Key transmission metrics and their relation to the malaria transmission cycle**

Metric	Definition	Use case	Limitations
<b>EIR</b>	Rate of infectious mosquito bites per person in a given unit of time	Detects early transmission changes; useful in high transmission settings	Requires complex entomological surveys; not always practicable or timely
<b>Mosquito density</b>	Number of mosquitoes per unit area or trap per night	Indicates vector abundance and potential transmission risk	Seasonal and spatial variability require frequent and consistent sampling
<b>Parasite prevalence</b>	Proportion of individuals with malaria infection in a given population	Indicates stable transmission levels; ideal for long-term trend analysis, especially in high-burden settings	Surveys are expensive and less responsive to short-term changes
<b>Malaria incidence</b>	Number of new malaria cases per 1 000 of the population over a specific period	Tracks disease burden based on routine health-care visits; sensitive to recent health-care seeking and transmission changes	Influenced by health-care access, diagnostic quality, population denominators and reporting consistency
<b>Morbidity</b>	Frequency of malaria-related illness in a population	Assesses overall disease burden; reflects success of interventions	Affected by health-care-seeking behaviour, population denominators and diagnosis accuracy

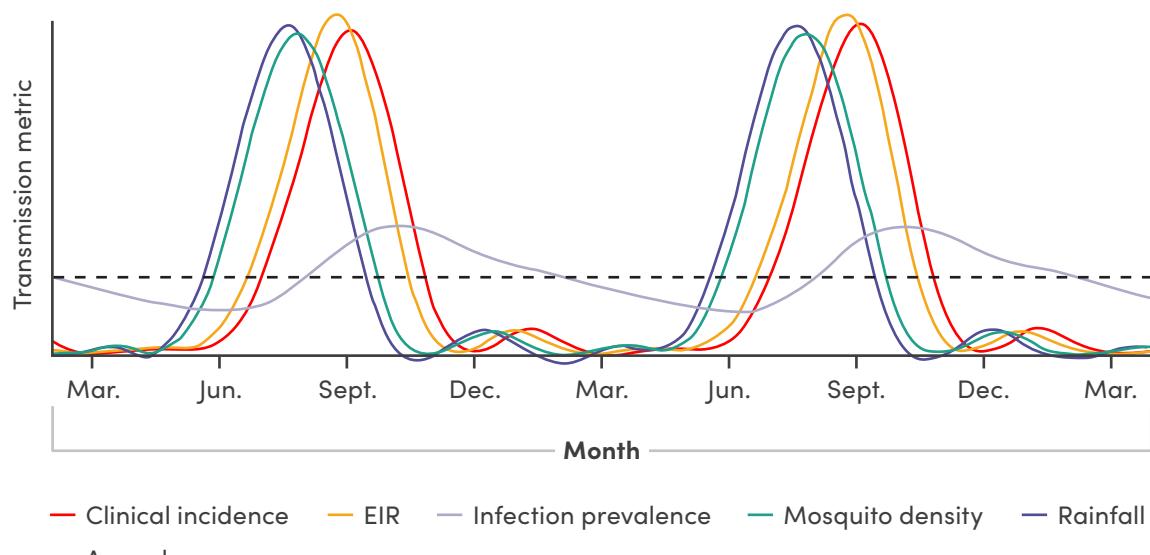
Metric	Definition	Use case	Limitations
<b>TPR</b>	Percentage of malaria tests that are positive	Proxy for malaria burden; useful for routine monitoring	Requires reliable recording of testing and consistent case definitions
<b>Mortality rate</b>	Percentage of deaths that are malaria-related	Assesses disease severity; reflects intervention outcomes in reducing severe cases	Delayed response to transmission changes; affected by multiple external factors, including health-care system access and quality
<b>ANC-based prevalence</b>	Proportion of pregnant women and girls testing positive for malaria at antenatal clinics	Provides routine, location-specific malaria prevalence data	Limited to ANC attendees, potentially excluding high-risk populations not accessing ANC services

ANC: antenatal care; EIR: entomological inoculation rate; TPR: test positivity rate.

In settings with seasonal malaria, transmission dynamics are influenced by seasonal rainfall patterns that create larval habitats, leading to increased mosquito density and subsequent peaks in entomological inoculation rates (EIR). While metrics such as EIR and case incidence are sensitive to recent transmission changes (because EIR reflects rapid shifts in mosquito infectivity and biting patterns, and clinical symptoms appear within weeks of infection), prevalence metrics are more stable and less responsive to short-term fluctuations (because parasite prevalence captures both symptomatic and asymptomatic infections that can persist for weeks or months). Fig. A3.2 illustrates how these metrics may vary over time in response to seasonal transmission patterns, emphasizing their complementary roles in informing malaria interventions.

Some metrics, such as the test positivity rate (TPR) and antenatal care (ANC)-based prevalence, may offer unique advantages for monitoring trends in routine settings and among specific populations, such as pregnant women and girls.

**Fig. A3.2. Typical relationships between different transmission metrics in seasonal settings**



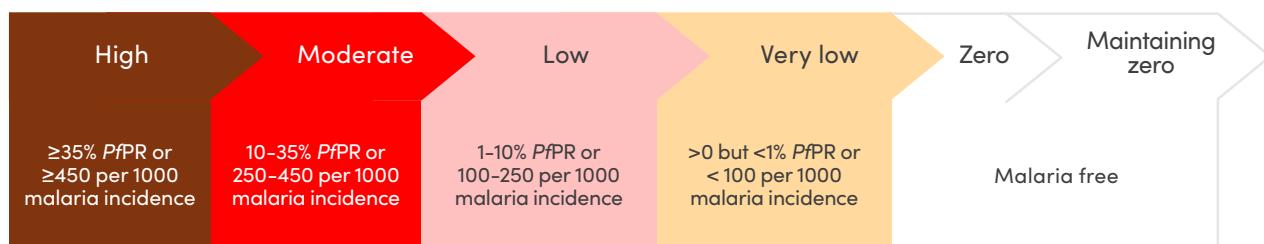
EIR: entomological inoculation rate.

In low transmission settings, malaria becomes concentrated in spatial pockets, making metrics such as absolute case numbers more useful for estimating burden and targeting interventions (compared to case incidence in higher transmission settings).

These metrics, combined with ecological data such as climatic conditions and urbanization, and entomology data such as vector species behaviour, provide a comprehensive understanding of transmission dynamics critical for SNT strategies.

Using the same metric and threshold over time simplifies the interpretation of changes in transmission. However, as data availability and quality improve, different metrics or thresholds may be needed. WHO provides guidance on transmission categories (Fig. A3.3), which can be adjusted based on the local context.

**Fig. A3.3. Categorization limits for epidemiological strata suggested by WHO  
(these thresholds should be modified to reflect local context)**



PfPR: *Plasmodium falciparum* prevalence rate.

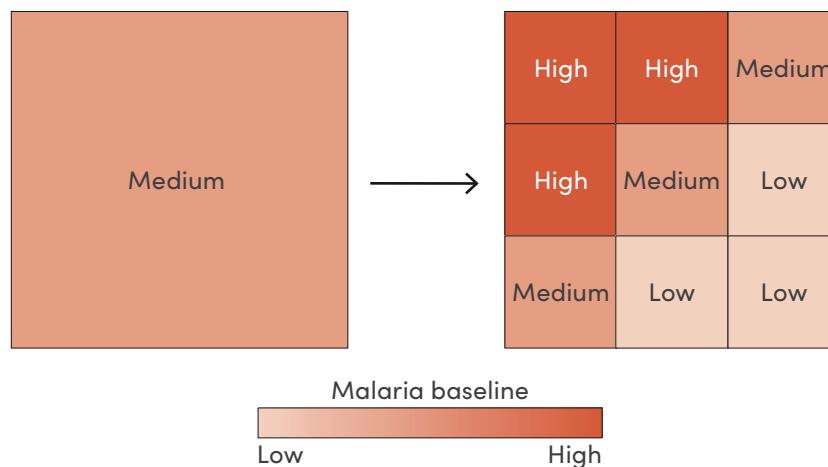
Source: WHO (1).

## A3.2 Estimating the malaria baseline

Malaria baseline represents the level of transmission and burden in the absence of interventions. Quantifying malaria baseline is critical for assessing changes over time. It provides a reference point to measure the impact of past interventions and understand the underlying malaria transmission dynamics in the absence of those efforts. The baseline varies between and within countries because of factors such as vectors, geography, socioeconomic and health system coverage, and it may shift over time with developments such as urbanization or land-use changes.

The malaria baseline is often measured using parasite prevalence or case incidence and can vary across different regions within a country. Analysis should be undertaken at the operational unit level. Fig. A3.4 depicts the outcome of using operational units for analysis in a country that has, on average, a medium baseline level of malaria. While analysing an entire country as a single unit provides a general view, dividing it into smaller operational units allows for more precise analysis and tailored interventions.

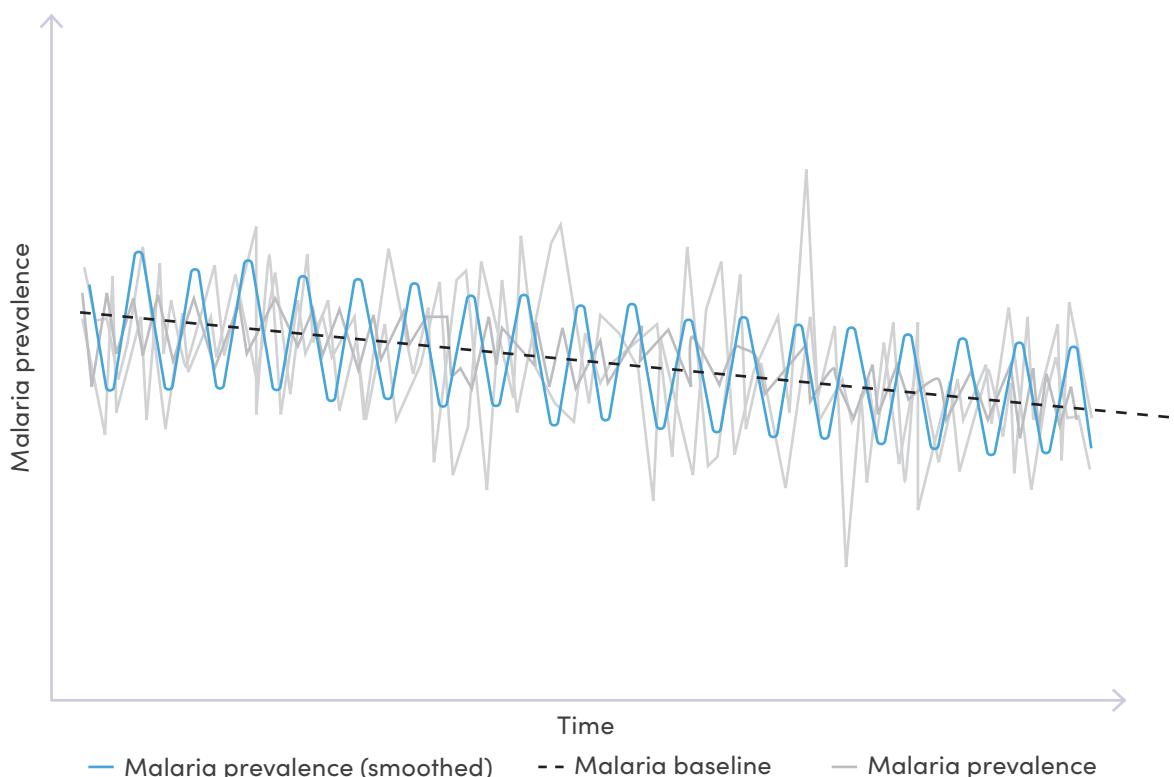
**Fig. A3.4.** Division of a malarious area into smaller operational units may reveal important variations in malaria baseline



Source: WHO (2).

In Fig. A3.5, grey lines represent the fluctuations that may be commonly observed in malaria prevalence due to many varying factors. The oscillations can be smoothed into a general seasonal pattern (depicted in blue). The fluctuations in this “noisy” malaria picture can be generalized in terms of the average prevalence of malaria that exists in a specific place at a particular time if no control measures are implemented. In this hypothetical case, the baseline is slowly trending downwards over time because of factors extrinsic to the malaria control programme.

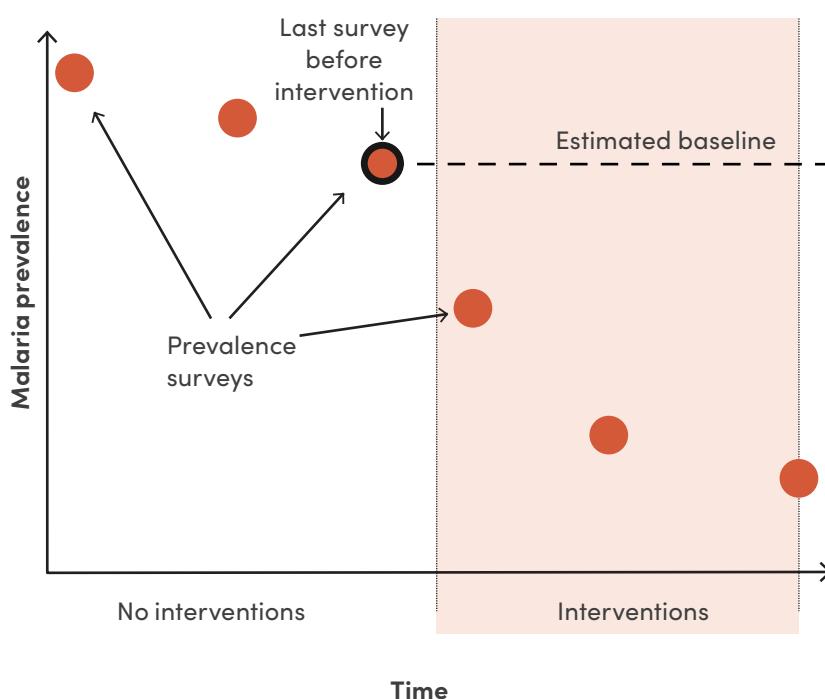
**Fig. A3.5.** Regular and irregular variation is simplified by describing malaria metrics on average rather than at a precise moment in time



Source: WHO (2).

If the malaria baseline were constant over time, observed prevalence from any surveys executed before control measures were implemented should be representative of the prevalence to which it would return if measures were removed. However, the baseline will rarely be constant and may change substantially over decades, especially in areas where urbanization or other land-use changes occur. A survey conducted immediately before implementing interventions is often the best estimate of malaria baseline available to NMPs (Fig. A3.6). If no such survey is available, historical prevalence surveys during earlier periods, when no interventions were being implemented, may be used instead, though consideration should be given as to whether the baseline may have increased or decreased over the intervening years.

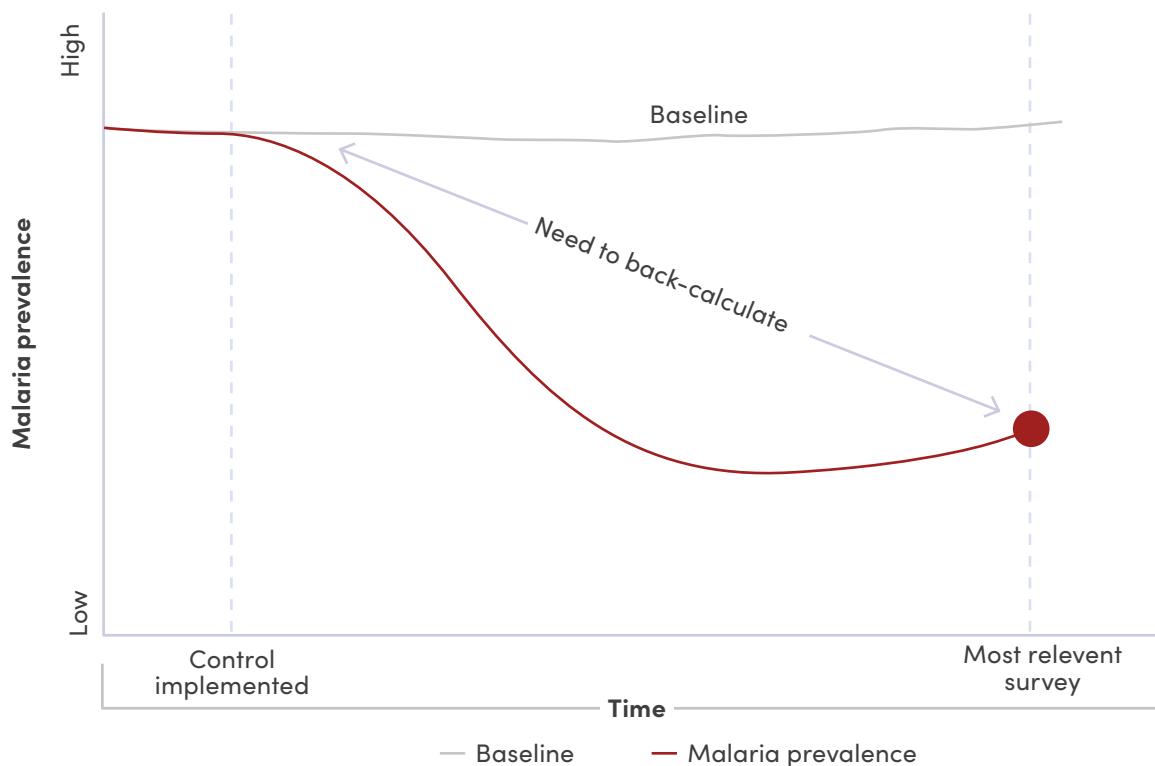
**Fig. A3.6. Baseline can be estimated from the last prevalence survey conducted before interventions were introduced against malaria**



Source: WHO (2).

In many settings, the scale-up of malaria prevention measures predates reliable surveys, and long-standing interventions combined with changes in housing, ecology, climate, and land use may have significantly shifted baseline malaria levels. To estimate the original baseline, it is necessary to evaluate the impact of interventions during early surveys and adjust baseline malaria levels upwards accordingly. Since the relationship between baseline and intervention coverage is complex and nonlinear, modelling is often needed to estimate the impact of interventions on malaria transmission dynamics. Such modelling approaches are increasingly available (see Annex 7). Data relating to the likely intrinsic effectiveness of interventions within a setting (e.g. vector bionomics, drug or insecticide resistance, degree of seasonality) can be used to estimate baseline and stratify areas with the same set of interventions and levels of risk according to the likely effectiveness of interventions (Fig. A3.7).

**Fig. A3.7.** In the absence of a pre-intervention survey, it will be necessary to account for the impact of interventions in reducing the malaria level from baseline to the level indicated by the most relevant survey, which may be the first survey after interventions started or the most recent one, depending on data availability and quality

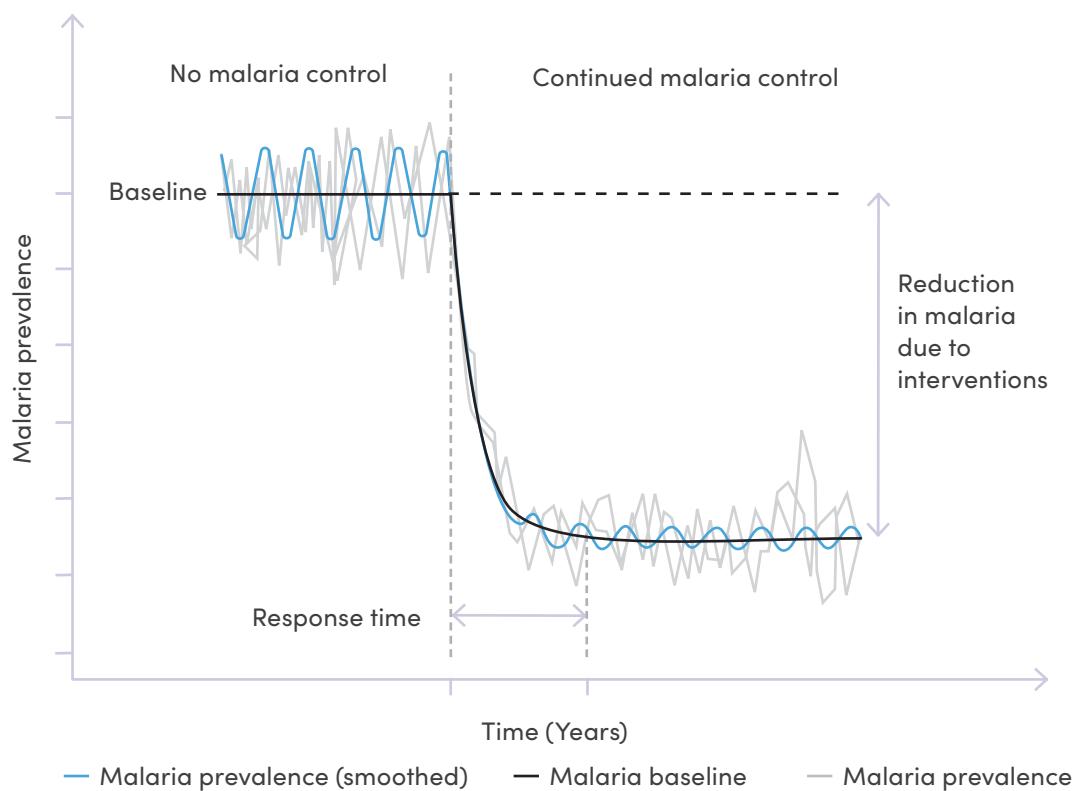


### A3.3 Estimating reductions from the malaria baseline

Effective interventions can reduce malaria from baseline levels by protecting at-risk populations. The reduction occurs over a specific period, known as the response time. Understanding malaria baselines and intervention history is crucial for determining whether the current burden results from intensive interventions or low baseline transmission risk, and this will guide future strategies.

Fig. A3.8 shows that the introduction of malaria control measures reduces the malaria level over the response time from the baseline level to a new, lower level of malaria that is sustained by continued malaria control. As with the characterization of the malaria baseline, it is not the fine fluctuations in malaria over time that are of interest, but rather the smoothed levels of malaria before and during control.

**Fig. A3.8. Protecting a proportion of the population will reduce malaria from its baseline over time**



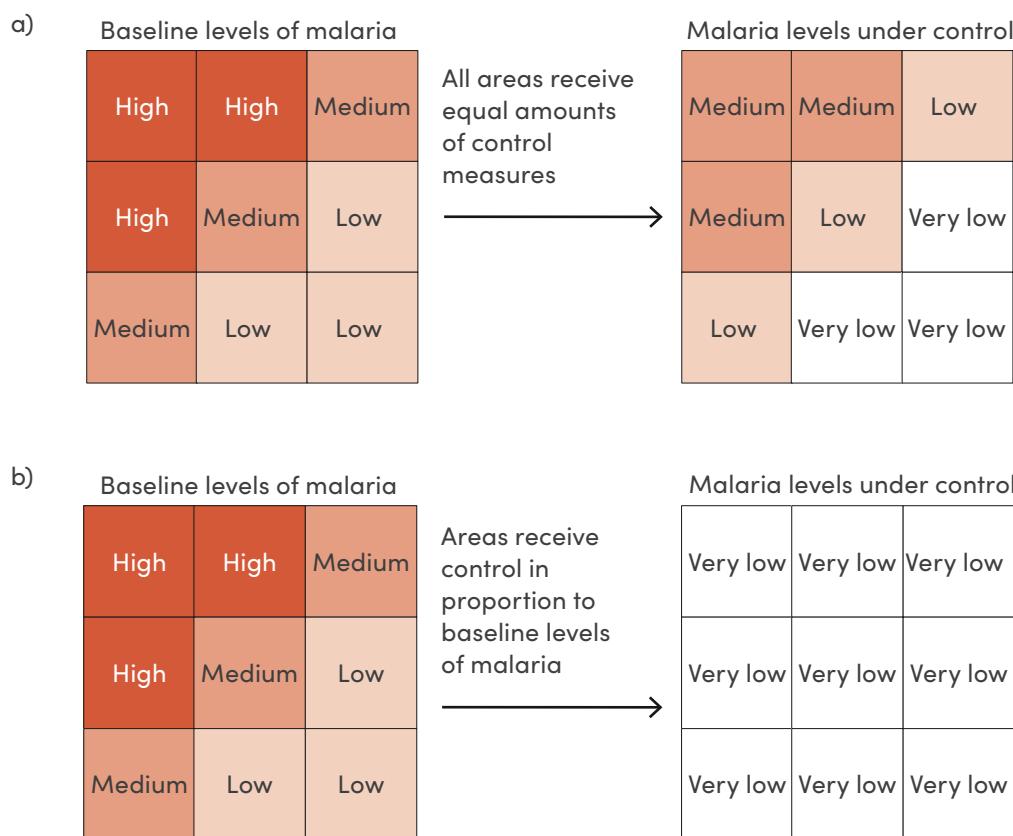
Source: WHO (2).

Reductions in malaria are influenced by various factors, including the effectiveness of interventions and their nonlinear relationship with epidemiological outcomes. For instance, areas with predominantly outdoor-biting vectors may not respond effectively to interventions targeting indoor mosquito behaviour, such as IRS or ITNs. Additionally, variations in weather, land use or human movement can significantly affect outcomes. The amount that malaria will be reduced from its baseline level in each operational unit (area) is determined primarily by the key factors below.

- **The baseline level** – in general, the higher the malaria baseline in a particular area, the greater the proportion of the at-risk population that must be protected with control measures to achieve a reduction in transmission to a specific threshold.
- **The magnitude of the impact of specific interventions on transmission** – this may vary by type of intervention, setting and drug or insecticide resistance. For example, the effect of ITNs and IRS will be greater where the dominant malaria vector(s) is night- and indoor-biting and indoor-resting, than in places where outdoor-biting and outdoor-resting vectors predominate.
- **The proportion of the at-risk population in the area that can be fully protected by effective control measures** – the greater the proportion that is protected (or covered), the larger the reduction that can be expected.
- **Effects of extreme weather, conflict, insecurity or migration events** – these can all disrupt systems and lead to epidemics.

If identical interventions are implemented across the entire country or region, reductions in malaria will vary in line with the different baseline level of malaria in each operational unit. That is, areas starting at higher baseline levels will end up with higher levels of malaria than those starting with lower baseline levels (Fig. A3.9a). To achieve the same level of transmission in all areas, those areas with a higher malaria baseline will need to use interventions with greater impact or achieve full protection of a larger proportion of the at-risk population than areas with a lower malaria baseline. If interventions are implemented in proportion to the baseline level of malaria, one could expect all areas to achieve similarly low levels under control (Fig. A3.9b).

**Fig. A3.9. a) Protecting the same proportion of the population in operational units with different malaria baselines will result in different outcomes; achieving reductions to the same level in all units requires protecting a greater proportion of the at-risk population in units with higher malaria baseline**



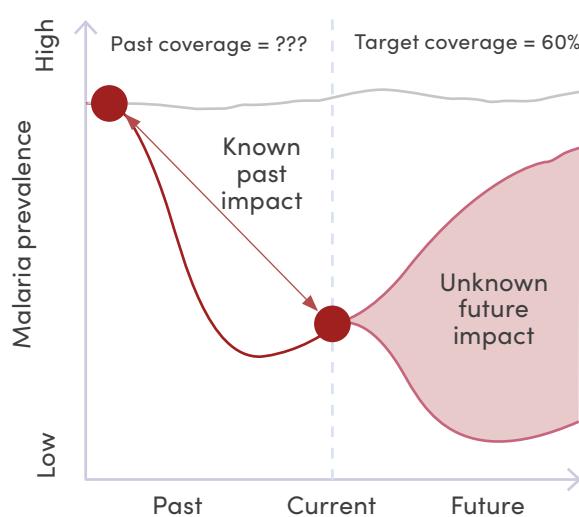
Source: WHO (2).

Detailed data on previously deployed preventive and curative interventions, entomology, intervention efficacy and land-use changes (e.g. urbanization) are key to understanding the likely incremental impact of any future interventions and changes in extrinsic factors. Fig. A3.10 shows two example scenarios under which the effectiveness of a current strategy in reducing malaria from its baseline is to be estimated. In Fig. A3.10a, despite knowing the baseline and current status, an absence of detailed data on previous intervention coverage levels makes it difficult to predict the future impact of a new target coverage. However, in Fig. A3.10b, data on the current level, baseline and the

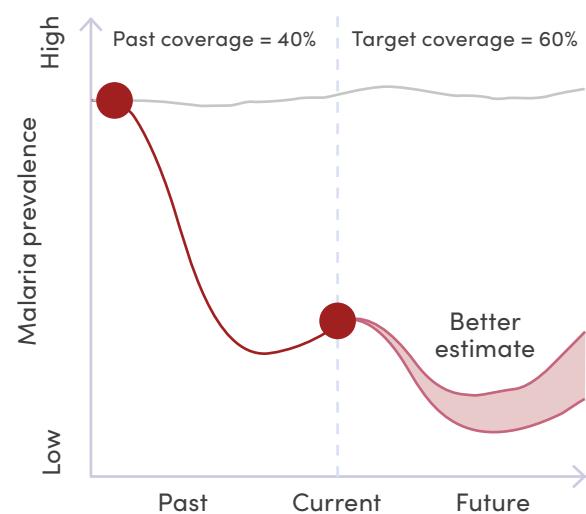
coverage of the intervention and other factors responsible for this change help reduce the uncertainty in projections of the likely future impact.

**Fig. A3.10. Data on impact alone is not sufficient (a). To understand the future impact of a strategy, data on previous interventions and other factors are needed (b).**

a)



b)



## References<sup>1</sup>

1. Malaria surveillance, monitoring and evaluation: a reference manual, second edition. Geneva: World Health Organization; 2025 (<https://iris.who.int/handle/10665/381864>).
2. From malaria control to malaria elimination: a manual for elimination scenario planning. Geneva: World Health Organization; 2014 (<https://iris.who.int/handle/10665/112485>).

<sup>1</sup> All references were accessed on 11 June 2025.

# Annex 4. Estimating effective coverage of malaria interventions

Effective coverage is usually estimated from data on typical coverage metrics, such as the proportion of individuals sleeping under an ITN across all seasons, taking into consideration all the factors that may reduce the efficiency of an intervention and estimating how much the effective coverage will be reduced. Countries are advised to ensure that such considerations are made for all interventions in the analysis of the impact of their programmes. The use of disaggregated or granular denominators in indicators – such as stratifying coverage by subpopulations (e.g. age groups, socioeconomic status, geographical regions) – can improve the accuracy of coverage estimates. This is especially important for interventions delivered through routine systems (e.g. ITN distributions via ANC or EPI), where using appropriate denominators such as the number of first ANC visits or the number of children eligible for immunization can provide a more precise assessment of intervention reach and impact.

As the most straightforward gaps are identified and addressed, closing the remaining coverage gaps for any particular intervention becomes increasingly challenging and costly. In some cases – especially where high coverage has already been achieved – the most cost-effective approach may be to enhance the effectiveness of existing interventions for those already covered or to shift focus to a different intervention.

This annex provides a guide to likely effective coverage gaps for commonly used interventions, the sources for data to measure gaps, and the resources typically needed to close them.

## A4.1 Effective coverage estimation and gaps in vector control

The main vector control interventions are ITNs and IRS, while LSM is a supplementary intervention used in specific settings; each is affected by different influences on effective coverage.

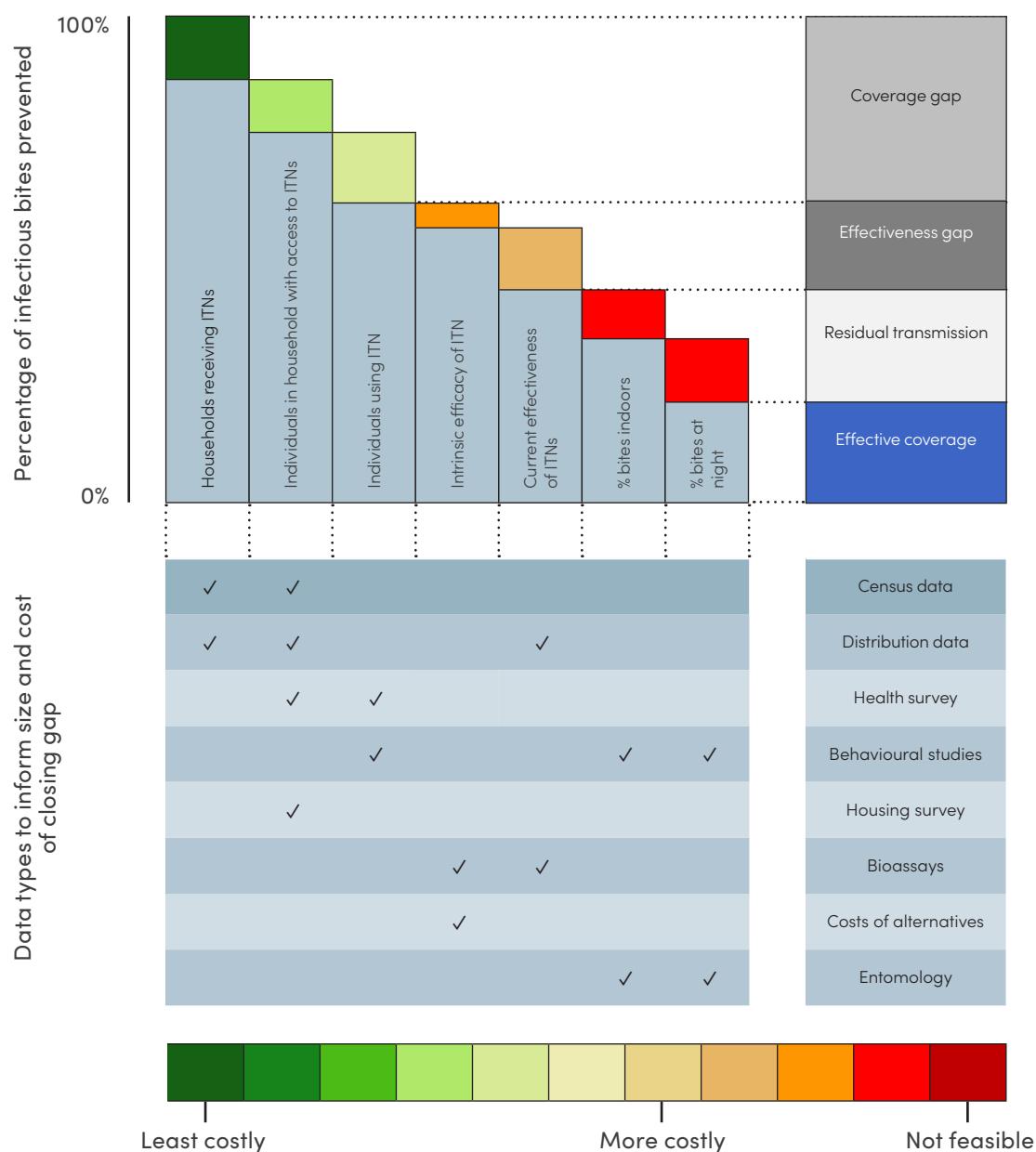
### A4.1.1 Insecticide-treated nets and indoor residual spraying

Fig. A4.1 illustrates the typical gaps in ITNs and IRS, key data sources to assess them and the relative cost of resources needed to address them – though these may vary by setting and implementation cycles.

In Fig. A4.1, the height of the colour portion of each column shows the contribution of each factor's effectiveness gap to the overall effective coverage of the intervention. The table

below the chart indicates the data required to quantify each gap and assess the cost of closing it. For example, in Fig. A4.1a, census data and ITN distribution data can be used to indicate that about 10% of households do not receive ITNs. This is represented by the colour portion at the top of the first column, and reduces effective coverage to about 90%. To close that gap of 10% is a relatively low-cost option (shown by comparison of the colour against the key). Each gap contributes to the overall gap in effective coverage.

**Fig. A4.1.a An illustration of gaps in effective coverage of ITNs**



**Fig. A4.1.b An illustration of gaps in effective coverage of IRS**

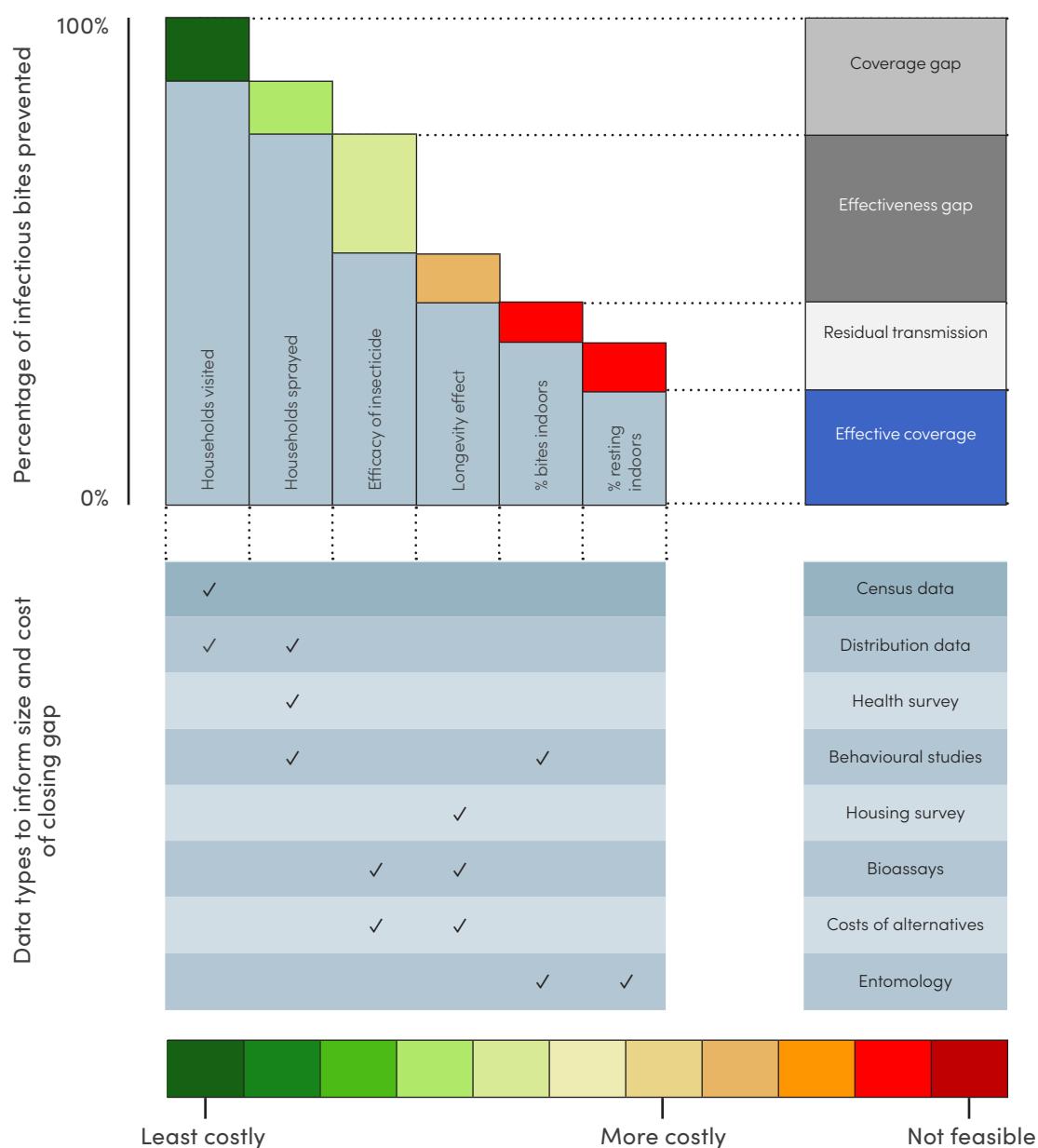
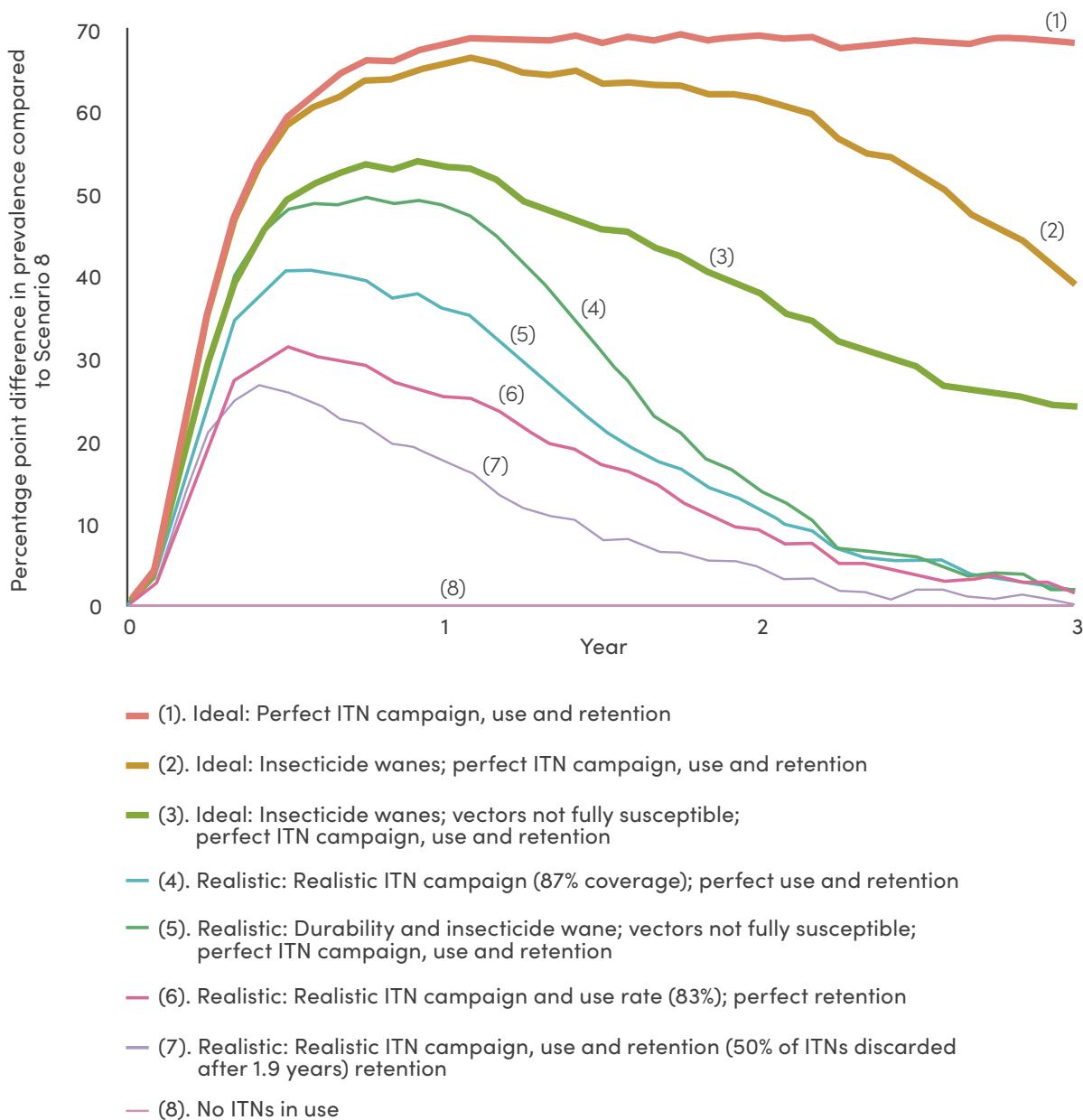


Fig. A4.2 illustrates the impact of seven different coverage gap scenarios in ITN use on malaria burden over time, compared with no use of ITNs. This represents various combinations of the effectiveness gaps identified in Fig. A4.1a. For example, Scenario 1 in Fig. A4.2 describes an ideal intervention where ITNs are distributed to 100% of households, used by all members of the household and retained forever. This achieves about a 70 percentage point decrease in malaria prevalence by the end of year 1 compared with Scenario 8 (no ITNs in use). Scenario 4 shows a more realistic intervention, where only 87% coverage is achieved. This achieves about a 50 percentage point decrease in malaria prevalence by the end of the first six months compared with Scenario 8 (no ITNs in use), but this impact reduces over time.

**Fig. A4.2 Impact of different coverage gaps on malaria burden over 3 years (modelling pyrethroid-only ITNs)**



ITN: insecticide-treated net.

Source: WHO (1).

Often, especially during the first few implementation cycles, the gaps in coverage are likely to be those that are most cost-effective to address. For example, overlaying programmatic distribution data with census data may identify areas and households that were missed and can be targeted when planning future mass distributions or within top-up campaigns between rounds. Information on the scale and timing of distribution should be available for each operational unit from programmatic data. All this can done efficiently using digital campaign microplanning and implementation tools. Surveys can also be used to assess barriers to access, which can be addressed by better-tailored distributions. Qualitative surveys of knowledge and attitudes towards the benefits of

vector control, and of barriers to use in those with access to the intervention, may also help to obtain insight into the benefits of behaviour change communication.

Various factors influence the effectiveness of ITNs such as type of net, coverage and use. Some factors are related to the waning of the quality of the net and durability (chemically and physically), compounded with insecticide resistance. An understanding of the lifespan and viability of the nets can be informed by detailed data on the timing of distribution of nets and information from durability, retention and resistance studies.

The effectiveness of IRS depends on factors such as insecticide selection, spray coverage, and the durability of insecticide residues. Physical modifications to structures can also reduce impact of IRS (2). Unlike ITNs, IRS requires precise timing to align with peak transmission and should be prioritized in high-burden or pyrethroid-resistant areas, settings with low ITN use and epidemic-prone regions. Resistance monitoring, wall bioassays and spatial risk stratification inform deployment, while digital tools enhance planning and efficiency.

Residual transmission is the gap in prevention of onwards transmission that persists even when interventions are implemented at perfect coverage and effectiveness. The gap due to residual transmission is impossible to close using interventions such as ITNs and IRS. Entomological surveys may, however, inform the need and incremental value of further interventions targeting transmission (e.g. if most transmission happens indoors but before individuals go to bed, IRS may be a more appropriate strategy than ITNs).

#### A4.1.2 Larval source management (LSM)

For LSM, effective coverage may be defined as the proportion of larval habitats that have been effectively treated. An LSM strategy should only be considered after careful and ongoing mapping of such habitats, along with assessment of their stability. Specific transmission metric thresholds for the application of LSM do not exist; instead, the requirement that all sources are few, fixed and findable leads to the use of LSM mostly in drier environments and urban settings (3).

### A4.2 Effective coverage estimation and gaps in chemoprevention

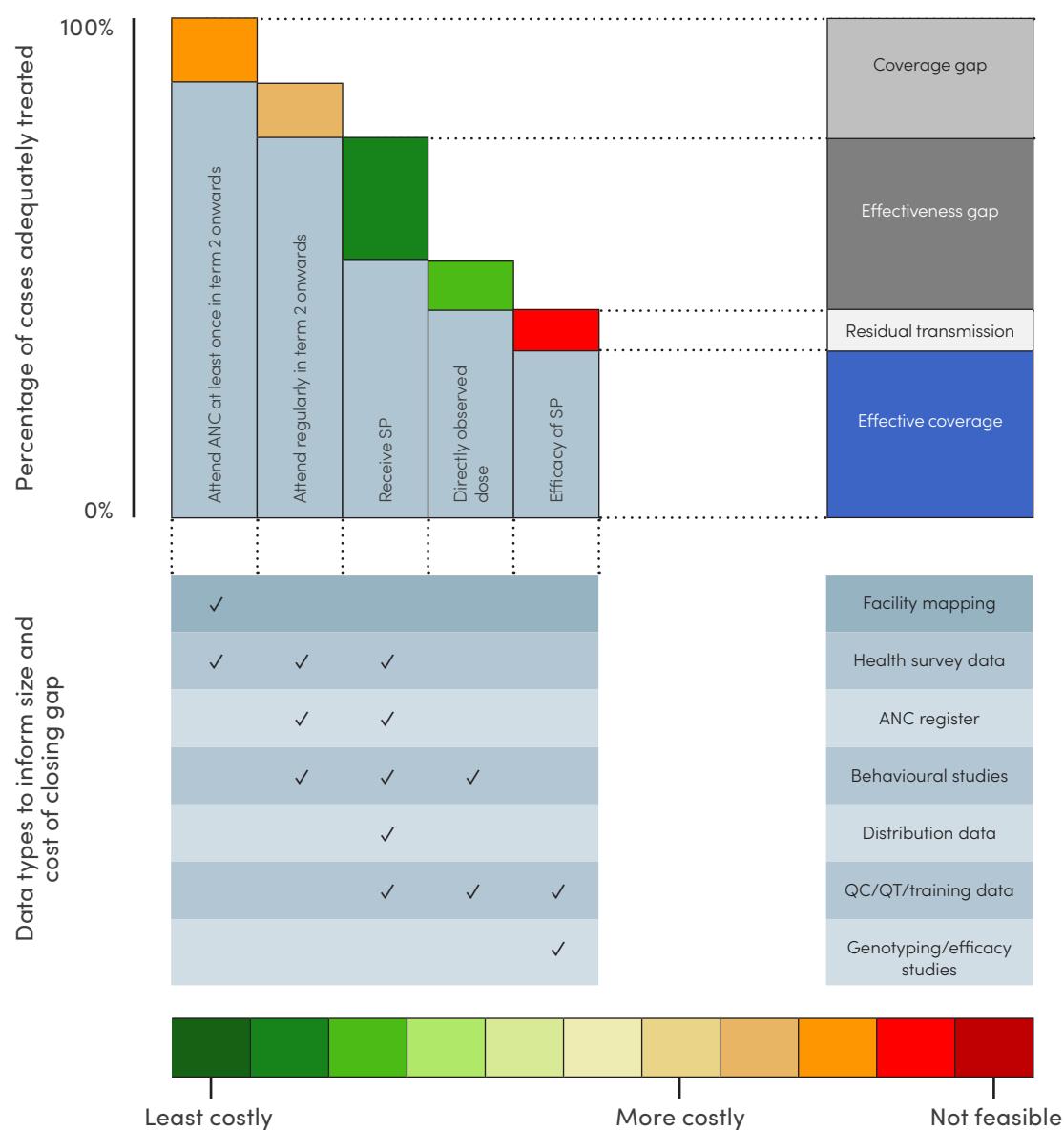
Chemoprevention tools such as IPTp, PMC and SMC are targeted at high-risk groups and aim to prevent infection and/or provide protection against clinical disease.

#### A4.2.1 Intermittent preventive treatment in pregnancy (IPTp)

IPTp has a broader range of geographical and year-round suitability than SMC or PMC and has been commonly implemented. IPTp prevents new infections and clears asymptomatic malaria in pregnant women, reducing the risk of adverse pregnancy and birth outcomes (4). Gaps in IPTp coverage (Fig. A4.3) include lack of or delayed ANC attendance, lack of SP stocks or administration during visits, and lack of SP efficacy in some patients. Stratifying data by age and gravidity is essential, as younger, primigravid

women – often with lower immunity – face higher risks and show lower ITN usage (5). IPTp with SP remains effective in regions with high prevalence of the K540E mutation in *P. falciparum*, but its efficacy in areas with the A581G mutation remains unproven (4, 6). Addressing gaps, particularly by improving SP availability and delivery at ANC visits, offers cost-effective opportunities to enhance IPTp coverage, as highlighted in existing WHO guidance on malaria control strategies (4, 7).

**Fig. A4.3. An illustration of gaps in effective coverage of IPTp with SP**



ANC: antenatal care; QC: quality control; QT: quality testing; SP: sulfadoxine pyrimethamine.

## A4.2.2 Seasonal malaria chemoprevention (SMC) and perennial malaria chemoprevention (PMC)

SMC and PMC are targeted interventions designed to protect young children in areas with seasonal and perennial malaria transmission, respectively. Effective coverage of both strategies depends on reaching eligible children at the right time and ensuring full adherence to the prescribed dosing schedules.

While effectiveness gaps are mostly related to the efficacy of the administered drug, gaps in coverage can be categorized into:

- access-related gaps (e.g. geographical, logistic or health system barriers limiting reach);
- adherence gaps (e.g. missed doses due to caregiver-dependent administration in SMC or incomplete immunization-linked dosing in PMC); and
- continuity gaps (e.g. children missing one or more SMC cycles or ageing out of PMC services).

For SMC, a key consideration is children with fever at the time of administration, who are often referred to health facilities or, in some cases, treated immediately and therefore do not receive SP+AQ, creating an additional coverage gap.

Furthermore, intervention coverage assessment is complicated by denominator inconsistencies in indicators, as the number of children dosed often exceeds the targeted population due to imprecise census data, movement across health districts, or overestimation of target groups. Disaggregating data by age, region, health facility or intervention round helps identify inequities, such as lower coverage in mobile populations, remote areas or communities with weak health infrastructure. Integrating PMC data with immunization performance metrics and tracking SMC coverage across multiple rounds ensures these interventions effectively reduce malaria burden in the most vulnerable populations.

## A4.2.3 Mass drug administration (MDA)

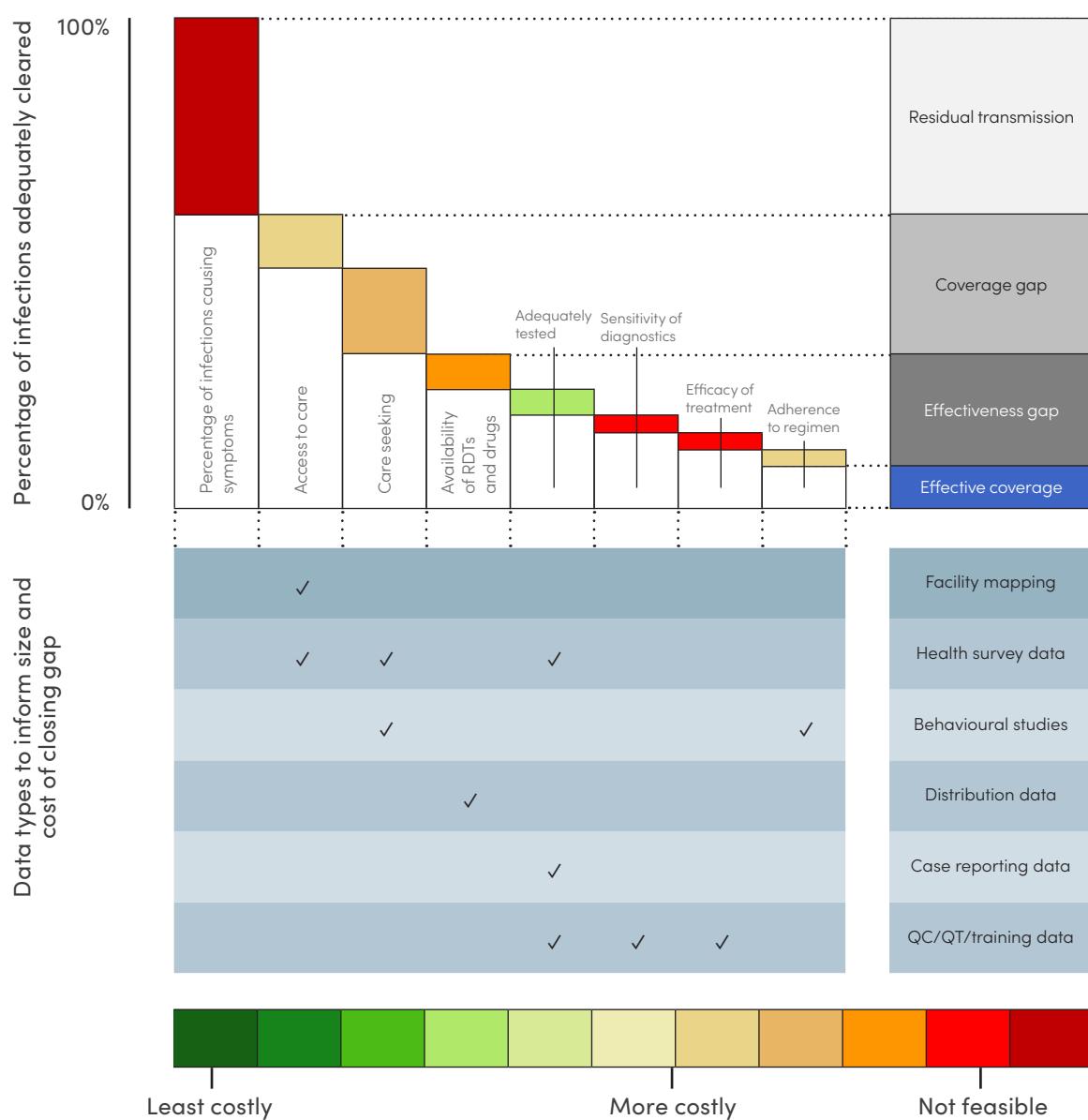
For MDA, effective coverage depends on the proportion of the infectious reservoir that can be reached. A key metric of impact is the proportion of the population receiving effective treatment. When multiple MDA rounds are conducted, the proportion of the population covered for every round becomes a major determinant of impact (8). Another challenge to full coverage is presented by mosquitoes infected immediately before each round, which contribute to residual transmission beyond the intervention's reach. In areas with seasonal transmission, MDA is expected to have the greatest impact when at least one high-coverage round is conducted towards the end of the dry season, when mosquito numbers are lowest. If MDA is used as a time-limited intervention, its sustained impact depends on effective and sustained vector control significantly reducing vectorial capacity during and following the MDA implementation period. Once vector control is interrupted, the time to return to pre-MDA malaria levels is likely to be longer in areas where the initial baseline was lower.

## A4.3 Effective coverage estimation and gaps in case management

The PHC system is the backbone of malaria case management. Cases are detected passively as individuals seek care at health service providers, primarily to receive treatment for mild and severe symptoms. Passive case detection followed by appropriate case management is essential to reducing mortality in malaria patients.

Several gaps affect effective coverage, including coverage gaps such as treatment-seeking behaviour and barriers to access of health services, stock outs of RDTs or first-line treatments at health facilities, and effectiveness gaps such as ACT drug resistance or *fphrp2* deletions that affect RDT performance (Fig. A4.4).

**Fig. A4.4.** A typical analysis of gaps in effectiveness for case management through health facility-based passive case detection



Eliminating stock outs of RDTs or first-line treatments at facilities will help close the effective coverage gap. Improving coverage in terms of access to health facilities and care-seeking behaviour has broader benefits beyond malaria. It can enhance overall health outcomes and the effectiveness of other interventions, such as IPTp and PMC during ANC (Fig. A4.3), and strengthen surveillance. CHWs play a key role in expanding health-care access and supporting malaria control efforts (9). The impact of CHWs depends on factors such as malaria prevalence in the community, the burden of febrile illness, the ratio of CHWs to the population, the level of training and supervision provided, the availability of supplies, and the overall strength of the health and surveillance systems.

Residual transmission is likely driven by individuals with asymptomatic or mild infections who remain unaware of their infection and do not seek care. This gap is challenging to quantify and is influenced by both current and historical endemicity levels. Individuals in areas with consistently low transmission are more likely to experience symptoms upon infection than those in areas with historically high transmission (63).

## A4.4 Effective coverage estimation and gaps in malaria vaccines

Malaria vaccines are delivered routinely through national immunization programmes. In the case of seasonal vaccine delivery, malaria vaccines are delivered just prior to peak season and may be delivered through usual vaccine delivery sites (fixed locations or outreach) or through campaigns. Factors that affect effective coverage of vaccines include:

- **supply and infrastructure** – supply and appropriate storage of vaccines and access to health service providers that administer vaccines (through fixed locations or outreach);
- **service utilization and accessibility** – use of EPI services and communication about the advantages of vaccination and the vaccine schedule;
- **adherence and implementation** – complexity of dosing and scheduling regimens and adherence of health workers and clients to vaccine schedules;
- **perception and uptake** – vaccine hesitancy and disinformation; and
- **monitoring and impact** – the extent of vaccine record-keeping and defaulter tracing, which can be used to manage coverage and assess the efficacy of the vaccine, including over time.

A description of how to calculate malaria vaccine coverage is found in the WHO malaria vaccine introduction guidelines (10).

## References<sup>1</sup>

1. World malaria report 2022. Geneva: World Health Organization; 2022 (<https://iris.who.int/handle/10665/365169>).
2. Opiyo MA, Paaijmans K. "We spray and walk away": wall modifications decrease the impact of indoor residual spray campaigns through reductions in post-spray coverage. *Malar J.* 2020;19(1):30 (<https://doi.org/10.1186/s12936-020-3102-6>).
3. Larval source management: a supplementary malaria vector control measure – an operational manual. Geneva: World Health Organization; 2013 (<https://iris.who.int/handle/10665/85379>).
4. WHO guidelines for malaria [website]. World Health Organization; 2024 (<https://app.magicapp.org/#/guideline/LwRMXj>).
5. Ndam JN, Azike PO. Analysis of the transmission dynamics and effects of containment strategies on the eradication of malaria. *Scientific African.* 2024;25:e02306 (<https://doi.org/10.1016/j.sciaf.2024.e02306>).
6. van Eijk AM, Larsen DA, Kayentao K, Koshy G, Slaughter DE, Roper C et al. Effect of *Plasmodium falciparum* sulphadoxine-pyrimethamine resistance on the effectiveness of intermittent preventive therapy for malaria in pregnancy in Africa: a systematic review and meta-analysis. *ancet Infect Dis.* 2019 May;19(5):546–556 ([https://doi.org/10.1016/s1473-3099\(18\)30732-1](https://doi.org/10.1016/s1473-3099(18)30732-1)).
7. Sicuri E, Bardají A, Nhampossa T, Maixenchs M, Nhacolo A, Nhalungo D et al. Cost-effectiveness of intermittent preventive treatment of malaria in pregnancy in Southern Mozambique. *PLoS ONE.* 2010;5(10):e13407 (<https://doi.org/10.1371/journal.pone.0013407>).
8. Brady OJ, Slater HC, Peter, Pemberton-Ross, Wenger E, Maude RJ et al. Role of mass drug administration in elimination of *Plasmodium falciparum* malaria: a consensus modelling study. *Lancet Glob Health.* 2017;5(7):E680–7 ([https://www.thelancet.com/journals/langlo/article/PIIS2214-109X\(17\)30220-6/fulltext](https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(17)30220-6/fulltext)).
9. Adhikari B, Bayo M, Peto TJ, Callery JJ, Tripura R, Dysoley L et al. Comparing the roles of community health workers for malaria control and elimination in Cambodia and Tanzania. *BMJ Glob Health.* 2023;8(12):e013593 (<https://doi.org/10.1136/bmjgh-2023-013593>).
10. World Health Organization. Guide for introducing a malaria vaccine into national immunization programmes. Geneva: TechNet-21; 2025 (<https://www.technet-21.org/en/resources/guidance/guide-for-introducing-a-malaria-vaccine-into-national-immunization-programmes>).

<sup>1</sup> All references were accessed on 11 June 2025.

# Annex 5. Stratification of malaria risk and interventions

## A5.1 Epidemiological metrics for stratification of malaria risk

Direct measures of transmission intensity such as EIR are rarely available for decision-making in malaria endemic countries. Therefore, indicators that reflect the epidemiological end points of malaria transmission on the human host and for which data are readily available to countries tend to be used instead. The most used metrics include:

- malaria parasite prevalence (burden of infection);
- malaria case incidence (burden of disease, both uncomplicated and severe) or case numbers in elimination settings; and
- mortality (burden of deaths) in the population.

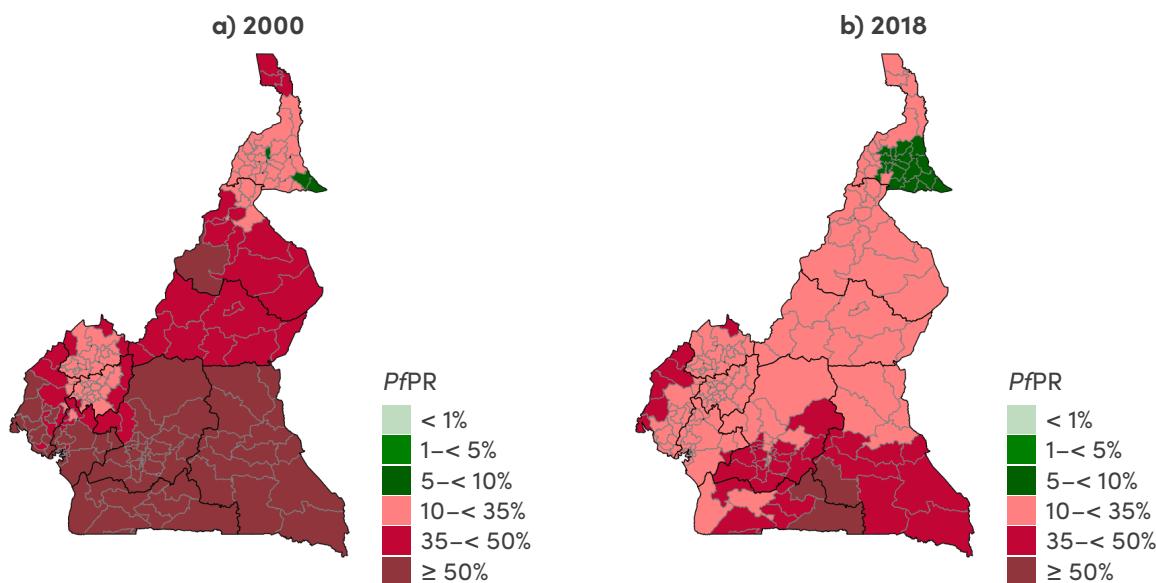
Countries frequently face incomplete datasets for stratifying these indicators across all operational units. To overcome this challenge, countries may use other metrics as a proxy (e.g. hospitalization as a proxy for severe malaria) and statistical and geospatial methods to address spatial and temporal gaps in data. In this section, we explore data and methodological approaches to stratify baseline and current malaria risk using key malaria metrics.

### A5.1.1 Malaria parasite prevalence

*Plasmodium* species-specific parasite prevalence, indicating the proportion of individuals (primarily children aged under 5 years) with parasitaemia, is typically derived from national household surveys conducted every few years. However, these surveys often lack the geographical and temporal granularity needed for SNT. Models using spatio-temporal statistical methods are needed to generate detailed estimates.

For this modelling, standard estimates are obtained using parasite prevalence information from household surveys and research publications combined with environmental, interventional and sociodemographic covariates. These data are used in a geostatistical model to predict parasite prevalence for a 1 km × 1 km pixel (or grid cell), and for relevant subnational units (Fig. A5.1).

**Fig. A5.1.** Estimates of *P. falciparum* parasite rate (PfPR) among 2–10-year-olds in Cameroon categorized using WHO risk classification in a) 2000, and b) 2018



Source: Malaria Atlas Project (1).

The uncertainty of the  $PfPR_{2-10}$  estimates for a country is a function of the sparsity of data and the reliability of geospatial modelling assumptions. The availability of household survey data used for such models varies by country and within countries by region or district. As such, when using this information, countries are advised to triangulate with other sources (e.g. ANC prevalence), epidemiological data (e.g. case incidence) and contextual information (e.g. population distribution).

### A5.1.2 Clinical malaria incidence

Clinical malaria incidence represents the number of newly diagnosed malaria cases during a defined period in a specified population, usually measured as total number of clinical cases per 1000 person-years at risk. In nearly all malaria endemic countries, routine data from the national HMIS can be used to estimate clinical malaria incidence.

The availability of accurate routine data at the relevant unit of analysis may vary per country. Countries have different subnational levels of access to care and treatment-seeking behaviours for febrile illnesses, access to parasitological diagnosis, and availability, completeness and quality of surveillance and population denominator data. (Although methods for estimating population demographics have been explored (2), most countries continue to rely on projected population census data for determining population denominators.) All these factors vary with time and between operational units, and affect the readiness of routine data for mapping and stratification of malaria risk.

Therefore, the raw case data extracted from the routine HMIS may need to be adjusted further for risk stratification. The following stepwise adjustment approach can be used to control for the common factors that affect the readiness of the routine data, with the objective of estimating clinical malaria incidence for each operational unit. The approach can be adapted to current context and the quality of the surveillance data.

- 1. Adjust for the testing rate.** To adjust for incomplete and heterogeneous testing rate data, a first correction is applied to the number of presumed cases using the test positivity rate (TPR = number of microscopy and RDT positive malaria cases/number of people tested with microscopy or RDT). This figure is then added to the number of malaria cases that have been confirmed by either RDT or microscopy. This adjustment allows an estimate of the number of cases not tested that were likely to be true malaria cases, assuming that the TPR among the presumed cases is similar to the TPR among the cases tested. The number of cases corrected for the testing rate is N1.
- 2. Adjust for the reporting rate.** Beginning with N1, a second adjustment is then made to account for the varying reporting rates per area-time by inflating the number of corrected confirmed cases by the fraction of the expected records that were not received. Through this step, it is assumed that the data not reported follow a similar distribution to the data reported. Reporting rates can be calculated per health facility type to avoid an overestimate or underestimate of the effect of missing data observed in smaller or larger health facilities, respectively. This adjustment gives N2.
- 3. Adjust for care-seeking behaviour.** Beginning with N2, a third level of adjustment is made to control for differences in care-seeking behaviour per area, which consequently affects the number of outpatients observed at the public health facilities that generally reported routine data to the HMIS. Regional level care-seeking rates – usually defined as the proportion of febrile children who sought care from a public or private health facility, – are obtained from the latest household survey conducted in the country along with data available from the Demographic and Health Surveys (DHS) Program, usually for children under 5 years old. Geospatial models can be used to estimate treatment-seeking behaviours at more granular units, though this is complicated by the various unmeasurable factors associated with care-seeking patterns. Depending on data availability, this adjustment may assume that i) the TPR of febrile children who seek care in the private sector or who do not seek care is the same as the TPR observed in the public sector; ii) the patterns of care-seeking behaviour in adults resemble those in children; iii) there is no crossover between sectors (i.e. a child who reported seeking care from the private sector or who did not seek care after a fever never presents to the public sector – but this may not be the case if the fever or other symptoms worsen); and iv) all districts that belong to the same region are assigned the region's public, private or non-seeking rates. These assumptions should be revised and are not all relevant or required in every country if more granular data or evidence are available (e.g. if malaria metrics are available for the private sector; evidence of care-seeking behaviour in adults or its relationship with children is known; treatment-seeking behaviours between sector and/or at district level are available). The adjustment for care-seeking behaviour gives N3.

The following formulae (which represent a modified version of one of the burden estimation methods used in the WHO world malaria report (3)) are used to adjust for each factor and estimate the number of cases for use in stratification (N3).

$$N1 = a + (b \times (a/c))$$

$$N2 = N1/d$$

$$N3 = N2 \times (1+(f/e)+(g/e))$$

where:

N1 = the number of cases corrected for testing rates;

N2 = the number of cases corrected for testing rates and reporting rates

N3= the number of cases corrected for testing rates, reporting rates and care-seeking rates

a = confirmed malaria cases reported from the public sector

b = presumed cases

c = tested cases

d = reporting rates (records received/records expected)

e = fraction of febrile children who sought care from the public sector

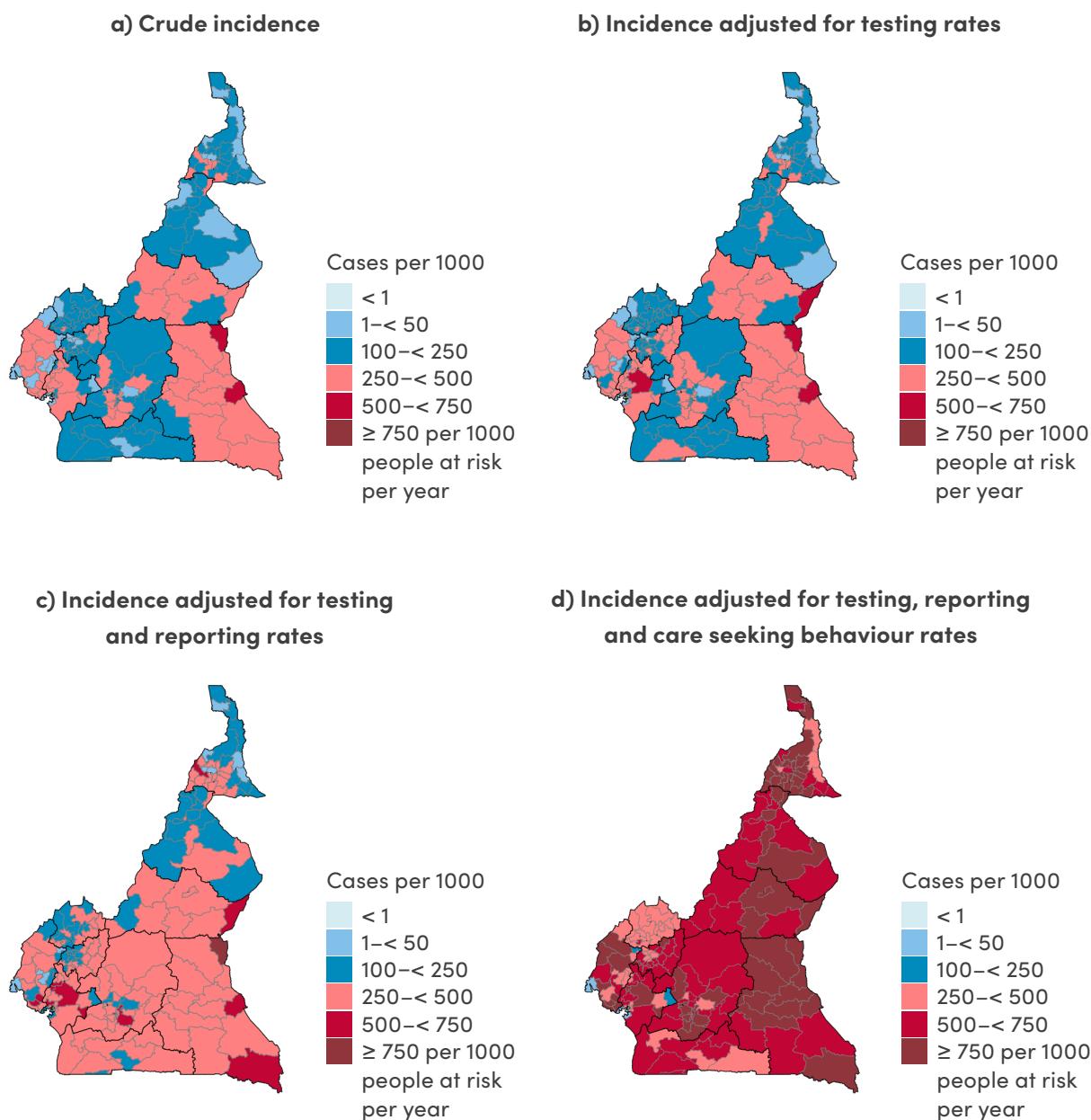
f = fraction of febrile children who sought care from the private sector

g = fraction of febrile children who did not seek care.

The crude and corrected incidence estimates in each district are divided by the population at risk. If the analysis is conducted at the monthly level, monthly incidence can be estimated by dividing the crude or adjusted number of cases by the estimated population of the district for the relevant year (where the population will be the same for all months of a given year). To calculate annual incidence estimates, the number of monthly crude or adjusted cases should be aggregated annually and divided by the annual population projections for that district-year. The estimation of N1 and N2 is highly encouraged at the monthly level to ensure that the seasonality patterns within a year are captured in the adjustments, before aggregating the crude and adjusted cases to the annual level to apply the third adjustment and obtain N3.

Once all incidence estimates are calculated, district-level trends and maps (Fig. A5.2) of the crude and adjusted incidence estimates need to be visually examined by NMPs. Discussions should be held to weigh the benefits and limitations of each adjustment until a consensus is reached on the best incidence metric to be used for intervention targeting. Countries are highly encouraged to review the standard approach provided here and adapt the equations, stratification bins and sources of data as they see fit for their context.

**Fig. A5.2. Clinical malaria crude and adjusted incidence estimates for Cameroon**



Source: WHO Global Malaria Programme and Cameroon NMP.

### A5.1.3 Malaria and all-cause under-five mortality

Where malaria is highly endemic, the disease is concentrated in young children, particularly those under the age of 5 years. Lack of prompt effective treatment can lead to progression to severe disease and death among these children. Given the low levels of access to care in many malaria endemic countries, malaria is consequently a major contributor to death in children under the age of 5 years.

Malaria mortality, defined as the number of malaria deaths per 100 000 population per year, can be estimated from vital registration systems and/or routine health systems registers. In most malaria endemic countries, direct estimates of malaria mortality will be complex and highly uncertain, given weak vital registration systems, low quality

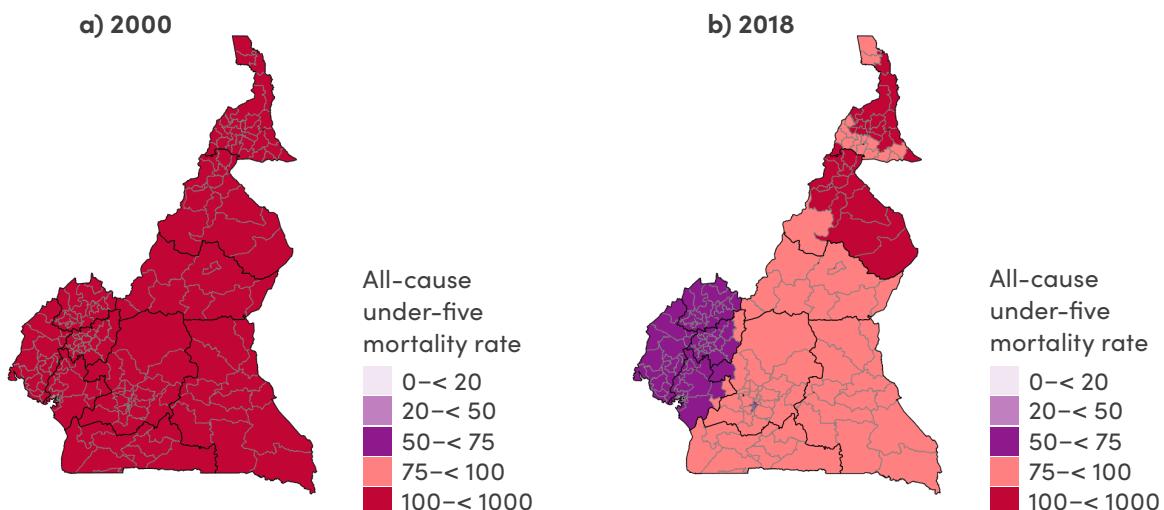
of severe malaria case management services, and low or poor reporting of hospital data. Attribution of malaria as a cause of death is also complex, especially in areas where patients have comorbidities with symptoms similar to malaria. As a result, malaria-specific mortality is usually indirectly quantified through a cause of death fraction derived from verbal autopsy data. Such tools have a very low level of specificity in correctly attributing malaria as cause of death.

When measuring or estimating malaria deaths is not feasible or is very uncertain, all-cause mortality is a potential proxy to estimate relative malaria mortality subnationally. Under the reasonable expectation that in highly malaria endemic settings, malaria is a major cause of death, particularly in children under 5 years, the coincidence of high malaria transmission and high all-cause mortality can be used to identify areas that are likely to have high malaria mortality. However, additional information on severe disease burden reported from inpatient facilities, age patterns of uncomplicated and severe disease, and the level of access to effective case management should be used to check such assumptions.

A common metric of all-cause mortality is the all-cause under-five mortality rate, defined as the probability (expressed as a rate per 1000 live births) of a child born in a specified year dying before reaching the age of five if subject to current age-specific mortality rates. Note that the all-cause under-five mortality rate should not be quantitatively compared with or interpreted as malaria mortality, as the populations (live births versus total population), denominators (1000 versus 100 000), and time periods (year of birth versus year of death) are different.

For countries with good death-record systems, national civil and vital registrations provide most of the information used to quantify mortality rate by age in the population. For other countries, especially in most of sub-Saharan Africa, summary birth histories and complete birth histories, often done every 5 years, are the main source of mortality data among children under the age of 5 years. In most countries, available mortality survey data are not sufficiently reliable to disaggregate below province or regional sampling domains. Statistical models can be used to develop district or lower-level estimates at the operational unit of decision-making (Fig. A5.3).

**Fig. A5.3. All-cause under-five mortality estimates in Cameroon, 2000 and 2018**



Source: WHO Global Malaria Programme and Institute for Health Metrics and Evaluation.

### A5.1.4 Combination of malaria risk metrics

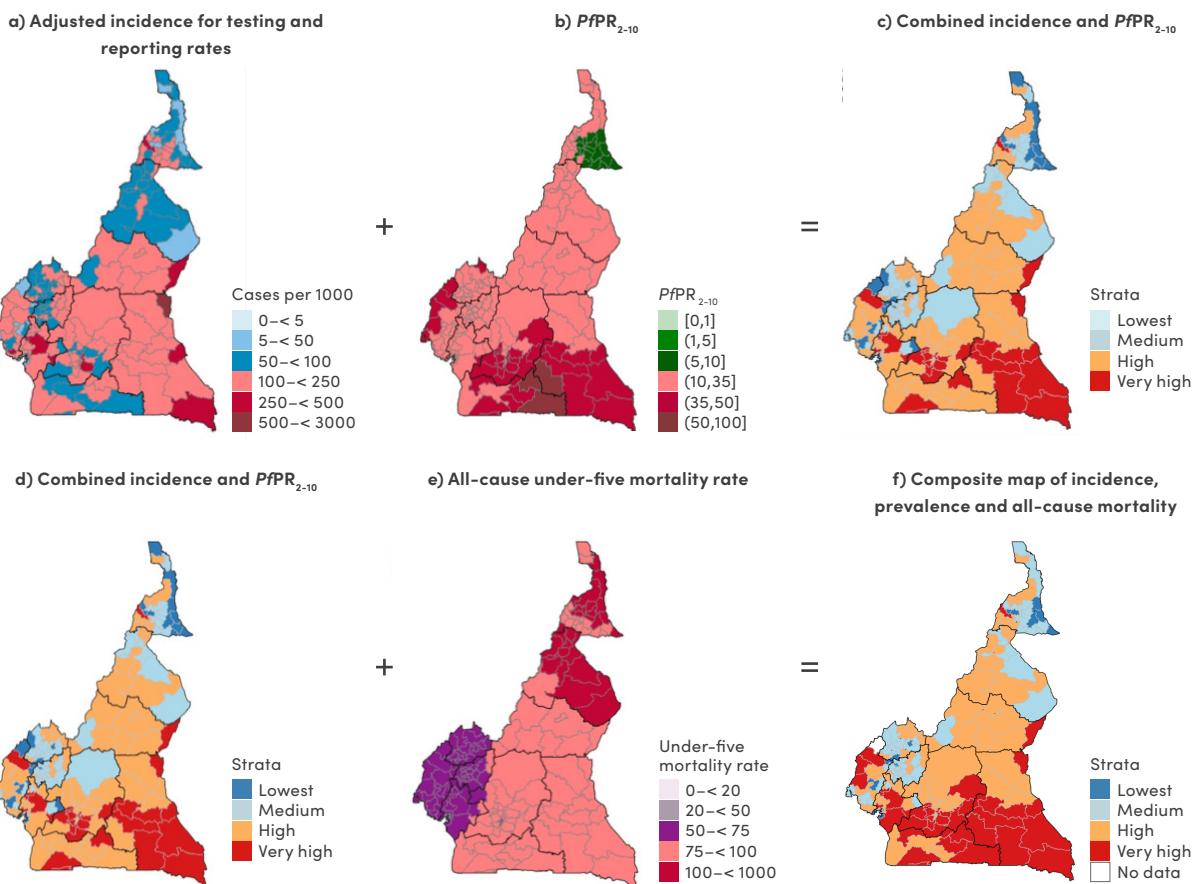
Given the uncertainties of the three common metrics of transmission and disease burden, and the different dimensions of malaria transmission that they represent, countries may choose to combine prevalence, incidence and/or mortality categories to develop a composite risk map. Several approaches can be applied to develop a composite metric (4, 5). A simple two-stage approach is presented here, but should be adapted to the country context.

- 1.** Scores are assigned in ascending order to the prevalence and incidence categories based on the number of strata used per metric. An example is shown in Table A5.1. These scores are then summed per operational unit, and the sum of the scores is reclassified in quartiles to obtain areas of “lowest”, “moderate”, “high” and “very high” morbidity.
- 2.** Once the first set of strata based on prevalence and incidence scores has been obtained, new scores are assigned to them from 1 (low) to 4 (high). At this stage, the categories for all-cause mortality in children under 5 years of age are also assigned in ascending order of 1, 2, 3 and 4 for mortality < 1, 1–< 6, 6–< 9.5, and ≥ 9.5 deaths per 1000 live births. These mortality categories were the ones used in the Africa regional map created for malaria vaccine allocation across countries, when the vaccine supply was severely limited (6). The selection of factors used to tailor and prioritize interventions, as well as the thresholds for stratification, should be adapted to the local context. The mortality score is then added to the combined prevalence and incidence score obtained in stage 1, and the sum of the scores are reclassified in quartiles to obtain areas of “lowest”, “moderate”, “high” and “very high” morbidity and mortality (Fig. A5.4).

**Table A5.1.** Example prevalence and incidence scores

Prevalence	< 1	1–< 5%	5–< 10%	10–< 35%	35–< 50%	≥ 50%
Prevalence score	1	2	3	4	5	6
Incidence (per 1 000 people at risk per year)	< 1	1–< 50	50–< 100	100–< 250	250–< 500	≥500
Incidence score	1	2	3	4	5	6

**Fig. A5.4. A composite risk map for Cameroon**



Source: WHO Global Malaria Programme and Cameroon NMP.

## A5.2 Stratification of malaria interventions and other determinants

While stratifying the country by baseline and current transmission intensity is essential for planning for SNT of interventions, understanding the determinants of malaria risk is equally crucial for effectively targeting specific interventions. This section presents key malaria transmission determinants commonly used to guide decisions subnationally.

### A5.2.1 Access and quality of care

The management of malaria cases is the foundational intervention in all malaria endemic countries to prevent severe malaria and death. Access to and quality of case management may vary substantially within a country and is often associated with high levels of inequity (7).

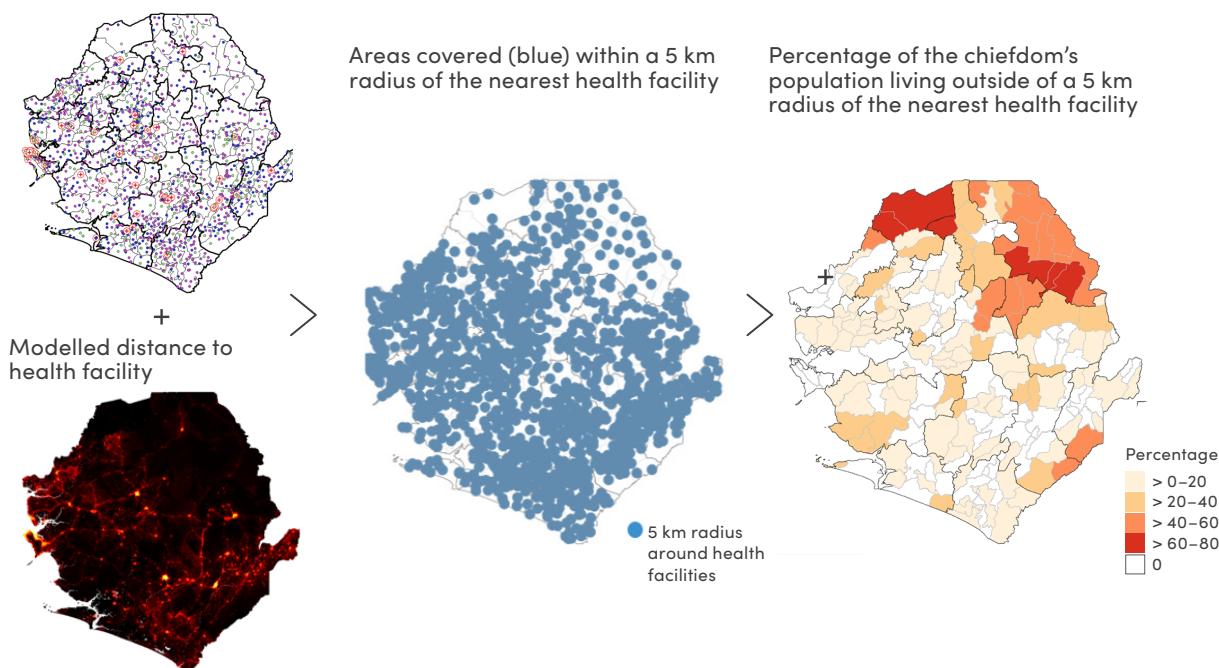
### A5.2.1.1 Access to health care

Access to health care can be measured using various approaches (8).

- **Geographical accessibility.** This method quantifies distance or time to a health facility. The estimation of distance can be done using standard geographic information systems and can be a Euclidean (straight line) estimate or network estimate (estimate of actual distance and/or time required to travel by road etc.). This can be done for all health facilities or specific types of health facility (e.g. a PHC facility versus a hospital). Typically, using the estimates of distance or travel time, a radius is drawn around the health facility (e.g. 5 km or 1 hour) and the population outside this distance or time are considered to not have adequate geographical access to health care. For each operational unit, the percentage of the population without adequate geographical access can be quantified. Critical inputs into this approach are data on the location, sector and type of health service providers, including CHWs, types of services offered (e.g. immunization, ANC) and population distribution (see, for example, Fig. A5.5).
- **Utilization rates.** Access to care is determined by more than geographical accessibility. Populations that are within easy reach of health facilities may still not seek care because of affordability, quality, perception and other factors. Overall treatment-seeking data is likely to provide an outcome measure that reflects the interplay of these factors on access to care. Household survey data enables estimation of utilization rates by sector or, more specifically, treatment-seeking rates, for each operational unit. However, such data may not be available for all countries and the basic geographical accessibility analysis, described above, may be applicable.
- **Composite access-to-care index.** The combination of geographical accessibility with treatment-seeking data can be revealing, especially if the variations of both can be estimated within each operational unit. For example, adequate geographical access but low utilization rates may indicate issues related to factors such as affordability or quality of care. Low access to care but relatively high utilization rates may suggest the population finds the health facility service attractive or perceives there is high risk of disease.

**Fig. A5.5. Geographical accessibility to health services in Sierra Leone, 2023**

Health facility locations



Source: WHO Global Malaria Programme and Sierra Leone NMP.

#### A5.2.1.2 Quality of care

Information on quality of care across the spectrum of malaria case management can be complex. However, some routinely collected data, as listed below, may offer useful insights. These indicators can be proxy measures of the quality of malaria care (9) and are amenable to direct systems or programmatic interventions.

- **Uncomplicated case management** – annual testing ratio (cases tested with RDT or microscopy divided by suspected cases); antimalarial treatment ratio (treated cases divided by confirmed positive cases).
- **Severe malaria management** – proportion of hospitalized patients who die before discharge; ratio of uncomplicated cases to severe cases; availability of functioning blood transfusion services; number of active or functioning inpatient facilities.
- **Stockouts** – frequency and duration of stock-out events for essential commodities; location of stocking stations; reasons for stock outs.
- **Health staff supervision and training** – number of annual supervision visits; training sessions by type; participants trained per operational unit.

#### A5.2.2 Preventive interventions

Data on interventions aiming to prevent malaria can be stratified based on relevant categories, including:

- location (ideally at the operational unit level) of interventions;

- timing of interventions (e.g. dates when the mass ITN campaign or IRS campaign took place, or when each round of SMC was implemented);
- populations that received the intervention (e.g. children aged under 5 years, pregnant women and girls);
- operational coverage achieved during implementation (which can usually be computed from distribution and microplanning information on targeted population versus population reached); and
- effective coverage after implementation (which is usually challenging to measure, especially for all operational units, given that it requires not only data on use of interventions, but their effectiveness – data sources such as implementation records, household and health facility surveys and research studies can provide insights into effective coverage, and even when data for each operational unit or the entire period of intervention coverage are not available, partial data can help identify opportunities for improvement and support the interpretation of current malaria burden indicators).

Where there is a gap between operational coverage and effective coverage, it is important to understand the cause(s), including the acceptability and appropriate use of interventions, because some of these factors are amenable to behavioural changes. This information is crucial for NMP decision-making on the sustainability of past interventions, and on scaling back interventions resource constraints require countries to decide where to interrupt interventions under the principle of causing the least harm.

Intervention-specific data can usually be obtained from the NMP and implementing partners for all available years. Various data sources can be used, as described below.

#### A5.2.2.1 Vector control (ITN, IRS) data

- **Routine ITN distributions through ANC and EPI programmes.** The number of ITNs routinely distributed through ANC or EPI can be extracted from the HMIS. The number of pregnant women who attended the first ANC visit and the number of children immunized at the time when the ITNs are usually delivered can be used as denominators to estimate coverage of routine ITN distributions.
- **Mass distribution of ITNs.** Data on mass distribution can be sourced from microplanning exercises (expected population and number of nets planned for distribution) and actual number and timing of ITNs distributed per district. Mass ITN universal coverage can be estimated as the number of nets distributed multiplied by 1.8 and divided by the population at risk (targeted population when available; otherwise, projected population per district (10)). Additional operational coverage estimates of interest to the NMP (such as nets distributed as a function of planned distribution) can also be explored.
- **Population-level ITN access, coverage and usage.** Data can be obtained from household surveys available to the country at the regional level, as well as from published and unpublished locally conducted studies.
- **Determinants associated with household and individual access to ITNs, and usage given access.** Data on these determinants (e.g. age, wealth, education, urbanicity) are usually collected through household surveys and locally conducted

studies. These data should be reviewed to guide the targeting of operational distribution strategies and social and behaviour change communication activities.

- **Net-specific durability.** Studies of ITN durability by the NMP or partners can be reviewed and discussed as a potential source of information to guide the frequency of mass ITN campaigns and to estimate effective coverage.
- **ITN deployment locations.** NMPs and implementing partners should have data on where different types of nets have been deployed and the number of nets distributed.
- **IRS deployment.** In districts where IRS activities are implemented, the timing of the IRS campaigns, the type of insecticide used, the number of households targeted and sprayed, and the population protected are generally available from the NMP or implementing partners. The coverage of IRS in each area can be estimated, if necessary, as the population protected by IRS over the population in that area (however, this metric may differ from population protected over population targeted).

#### A5.2.2.2 Chemoprevention (IPTp, SMC, PMC)

- **IPTp data.** To monitor the implementation of IPTp, the number of pregnant women and girls treated with one, two, three, four or more doses of SP can be collected and compared with the number of women who attended the first ANC visit. This will calculate district-level IPTp coverages. These data can be obtained from routine ANC registers or the HMIS. Regional coverage estimates of IPTp can also be obtained from household surveys.
- **PMC data.** Countries that have scaled up PMC through the EPI platform can obtain operational coverage information from routine reports or HMIS by dividing the number of children covered per scheduled dose by the number of children immunized in accordance with the PMC schedule.
- **SMC data.** To understand the extent and quality of implementation of past SMC activities, data on the number of targeted and treated children with SP+AQ per SMC round should be collected per area and year. The timing of the rounds, as well as any additional information pertinent to a specific country (number of febrile children excluded and referred to the nearest health facility, adverse events, malnutrition status, etc.), can be used to better understand coverage and identify areas for operational improvement. Most often, these data are obtained from targeted household surveys and programme implementation records; however, community feedback mechanisms (e.g. through CHWs) may also provide insights.

#### Malaria vaccines

- **Administrative vaccine data.** The uptake of all vaccines, including malaria vaccines, is monitored through administrative data collected at the health facility and reported through routine channels, such as DHIS2. WHO recommends monitoring doses 1, 2, 3, and 4 (and 5 where a five-dose schedule is introduced). Drop-out rates between doses should also be calculated. Countries are

encouraged to compare malaria vaccine doses with MCV1 (the percentage of children who have received the first routine dose of malaria-containing vaccine) and MCV2 (the percentage of children who have received the routine second dose of malaria-containing vaccine) to assess for missed opportunities to vaccinate, per usual practice. Population-based coverage can be measured through targeted household surveys. Strong collaboration with the EPI department is essential.

## A5.3 Stratification of malaria seasonality

Malaria seasonality can be analysed in different ways depending on the type of information required to guide the targeting of a given intervention. For example, the measurement of seasonality is a critical input into SNT for SMC and some other interventions (e.g. seasonal delivery of malaria vaccines).

WHO has published guidance on SMC implementation (11). WHO recommends SMC in districts with highly seasonal malaria transmission, defined as more than 60% of cases occurring within four or fewer months annually, and with moderate or higher transmission levels. Ideally, seasonality patterns should be evaluated using monthly or weekly confirmed case data from HMISs, focusing on either all-age cases or under-five cases, depending on local context.

However, routine data are often biased. This bias can arise from factors such as variations in care-seeking behaviour and reporting rates or the impact of past interventions, which can distort the detection of true seasonality and lead to misinformed SMC eligibility and targeting decisions. To address these challenges, rainfall trends can be analysed as an alternative, based on the assumption that rainfall patterns are a primary driver of malaria seasonality. Local experts should validate this assumption for each operational area and consider additional factors such as irrigation schemes, mining activities, or other environmental conditions that may influence seasonality.

Pixel-level rainfall estimates can be extracted from satellite sources, such as Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) data (12), and averaged to the operational unit level over at least 10 years. These estimates should be validated against in-country weather station data where possible. Defining the number and timing of SMC cycles, typically 3–4 months but up to 5 months in some areas, is critical for effective implementation. Combining rainfall analysis with reliable case distribution data allows for determining the number of cycles and identifying optimal start and end months, accounting for regional seasonality differences.

Box A5.1 proposes a methodology to identify seasonal areas eligible for SMC or seasonal vaccine delivery following WHO guidance. This approach does not provide information regarding the duration of the transmission season peak; nor was it designed to identify areas with sharp bi-modal seasonality patterns, which are usually observed in some areas of Central Africa and outside sub-Saharan Africa.

### Box A5.1. Algorithm to identify areas with seasonality patterns consistent with SMC or seasonal vaccine delivery

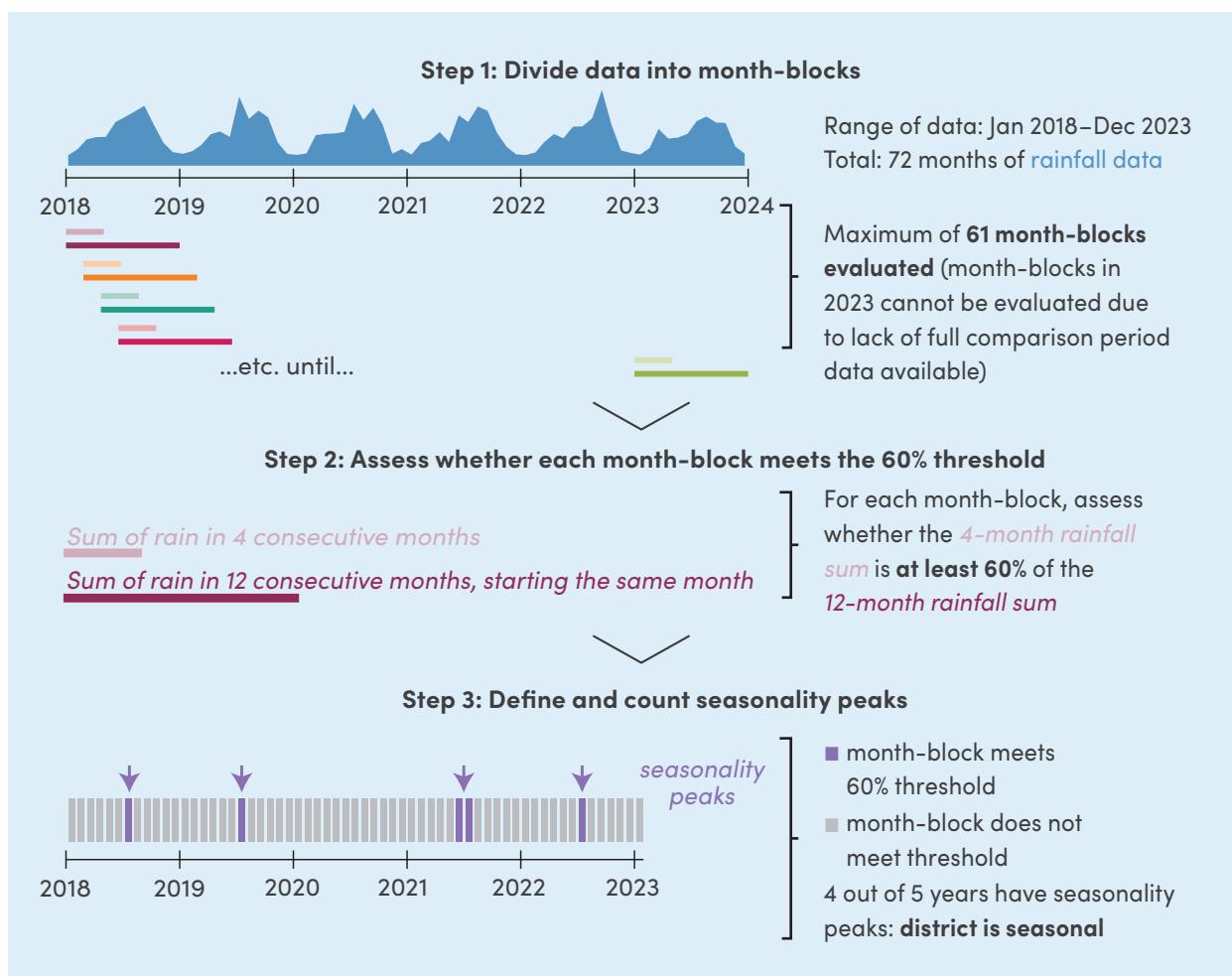
Overview: The following method assesses whether seasonality in an area meets WHO's definition of > 60% of cases occurring within a 4-month period. The description below uses rainfall, but the same method can be applied to either case data or rainfall data.

Approach: For a given 4-month period (the evaluation period), the total rainfall in the period must be compared to total rainfall in a 12-month period (the comparison period) that encompasses the evaluation period. In this example, the comparison period is the 12 months beginning the same month as the evaluation period.

For every given month of the time series ( $i$ ), the sum of the rainfall ( $R$ ) observed during that month and the following 3 months ( $R_i + R_{i+1} + R_{i+2} + R_{i+3}$ ) is divided by the sum of the rainfall for that month and the following 11 months ( $R_i + \dots + R_{i+11}$ ), then multiplied by 100. The 4-month period constitutes a "month-block" (evaluation period) for month  $i$ , leading to a total of  $T - 11$  month-blocks, where  $T$  is the total number of months in the time series (ideally  $T$  should be  $\geq 60$ ).

Each month-block meets the 60% threshold if the sum of rainfall during the 4-month evaluation period is > 60% of the sum of rainfall of the following 12-month comparison period. One or more consecutive month-blocks that meet the 60% threshold are together considered a seasonality peak. An area can be identified as seasonal for SMC when seasonality peaks occur consistently throughout the time series under consideration; for example, in at least 60% of years.

For example, a district with 6 years (72 months) of data between January 2018 and December 2023 would have 61 month-blocks (between January 2018 and January 2023) for evaluation. If a sharp peak in rainfall is observed around June of every year, month-blocks that include June (at least one of the month-blocks of March–June, April–July, May–August, and June–September) would be identified as "seasonal for SMC", and a seasonality peak would be identified. If seasonality peaks are identified for 4 out of the 5 years of the time series, the district would be identified as having a seasonality that satisfies the eligibility requirement for SMC. Ideally, 5 years of monthly data is required for this approach, which is 60 months or more.



WHO recommends **malaria vaccination** for children living in areas of highly seasonal malaria transmission or in areas with perennial transmission with seasonal peaks, using an age-based, seasonal or hybrid approach. The seasonal approach aligns the period of highest vaccine efficacy, during the months after vaccination, to the period of highest malaria transmission. It has been shown to provide high vaccine efficacy and impact in areas of highly seasonal transmission (14, 15).

Using the seasonal approach to vaccination, the first three doses are given to children in a defined age range (e.g. 5–36 months) just before the high transmission season, with the fourth and fifth doses given annually just prior to the subsequent high transmission seasons. Using the hybrid approach, the first three doses are given monthly from 5 months of age, with the fourth and fifth doses given annually just prior to the subsequent high transmission seasons. Guidance for vaccine introduction using the seasonal or hybrid approach is available as part of the WHO malaria vaccine introduction guide (16). Countries implementing both SMC and malaria vaccination are encouraged to integrate communication activities to increase uptake of both interventions.

## A5.4 Urban microstratification

The characteristics of malaria transmission and the malaria burden in urban areas require specific adaptations of preventive interventions and strategies to expand access to care to target clusters of transmission. The WHO framework for malaria response in urban areas (17) details the control and elimination of malaria in urban areas.

Malaria risk in urban settings can be defined using epidemiological and entomological metrics. Risk may also be defined based on the determinants of transmission. These include environmental factors, such as distribution of potential breeding places for local vectors, level of urbanization (urban, suburban, periurban, rural fringe), housing and infrastructure (informal settlements), ground coverage, climate and seasonality, and demographic factors, such as population size and occupation types. Often, no single type of data can adequately define malaria risk, and triangulating different sources of information is helpful in the process of risk microstratification.

Epidemiological information from routine surveillance systems, even at the aggregated level, can be a good source of data on the distribution of malaria in urban settings. Routine malaria data often suffer from mismatches between the point of care and patient residence, especially in urban areas with large hospitals and health centres. In urban settings, a significant portion of cases may be imported, but the absence of travel history data complicates the process of understanding transmission dynamics. Additional challenges include incomplete reporting, reliance on symptom-based diagnoses and exclusion of private-sector and self-treatment cases from surveillance systems. Addressing these gaps is essential for accurately assessing malaria burden and tailoring interventions in urban areas.

## A5.5 Mapping vulnerable and high-risk populations

Sociodemographic factors influencing malaria transmission and control – such as population growth, socioeconomic shifts, displacement and migration – must be accounted for in national malaria strategic and implementation plans. However, data standards for these factors vary across countries, requiring the integration of multiple data sources and methods to enable accurate planning.

Efforts should focus on identifying and mapping vulnerable populations that require tailored malaria interventions (18). These may include communities in conflict-affected areas with dysfunctional health services, refugee or internally displaced persons camps, populations in institutional settings with limited autonomy (e.g. prisons, psychiatric hospitals, orphanages), and mobile groups such as pastoralists or nomads. Understanding these populations' unique risks and barriers to access ensures that interventions – whether case management, vector control or chemoprevention – are effectively adapted to their specific needs.

In many countries, especially those nearing elimination, highly mobile populations, such as forest workers, are at higher risk of malaria, contribute a considerable proportion of the burden and may be a reservoir of transmission. Given the highly mobile nature of these populations, the place of residence is often not the place of infection. Therefore, the process of tailoring interventions will require information collected through prospective qualitative and quantitative surveys (Table A5.2).

**Table A5.2.** Example: information that may be considered in the design of effective interventions for forest workers

<b>1. Demographics and risk profile</b>	Age and sex Size of forest worker population Frequency of malaria episodes Prevalence of malaria infection Mobility and migration patterns
<b>2. Behavioural and occupational patterns</b>	Purpose of forest visits Location of the forest(s) Frequency and duration of stays Daily routines and sleeping arrangements in the forest Participation in formal versus informal work Personal and communal protection practices in the forest
<b>3. Health access and care-seeking</b>	Access to health services before, during and after forest stays Use and source of malaria treatment Knowledge of malaria symptoms, transmission, diagnosis and treatment Risk perceptions and beliefs about malaria
<b>4. Communication and social context</b>	Language and literacy Trusted sources of health information or influence (e.g. employers, peers, local leaders)

This information will then guide the prevention, treatment and behavioural interventions needed to reduce the burden of malaria in forest workers.

## A5.6 Elimination settings

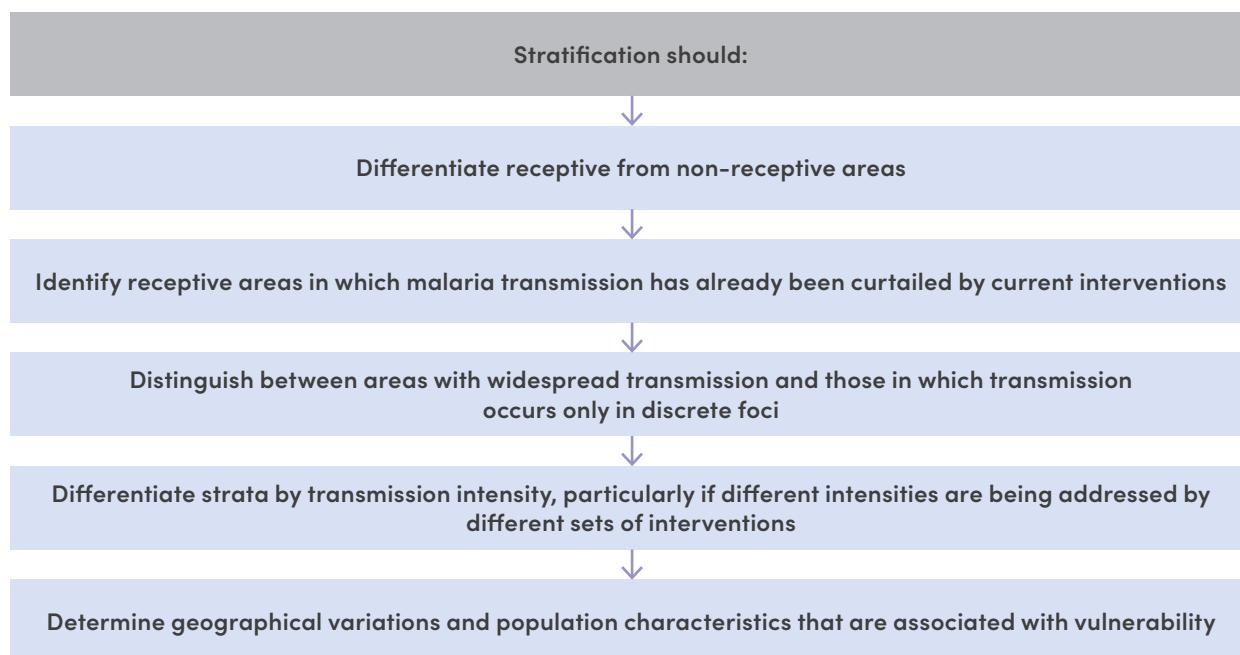
In countries nearing elimination, malaria becomes even more heterogeneous, with spatial clusters of relatively high transmission existing amid large areas that have become free of malaria. Such an area of relatively high transmission is labelled a focus, which is defined as a circumscribed area situated in a currently or formerly malarious area that contains the epidemiological and ecological factors necessary for malaria transmission (19). WHO classifies foci into three main types: active, residual non-active and cleared (Table A5.3). Focus classification is maintained in a national focus register and the focus type is reviewed regularly (often annually) to allow for reclassification.

**Table A5.3.** Focus classification recommended in the WHO framework for malaria elimination

Type of focus	Definition	Operational criteria
<b>Active</b>	A focus with ongoing transmission	Indigenous case(s) have been detected within the current calendar year.
<b>Residual non-active</b>	Transmission interrupted recently (1–3 years ago)	The last indigenous case(s) was detected in the previous calendar year or up to 3 years earlier. Fig. A5.4.
<b>Cleared</b>	A focus with no indigenous transmission for more than 3 years	There has been no indigenous case for more than three years, and only imported and/or relapsing and/or recrudescent and/or induced cases may occur during the current calendar year.

Source: WHO (19).

The focus classification is the basis of elimination stratification (Fig. A5.8), which starts with identification of areas that can support malaria transmission (receptive) and those that cannot (nonreceptive). In nonreceptive areas, the focus is on timely detection and quality case management. In each receptive area, a further determination is made on whether the area still has malaria (active), is malaria free for at least 1 year (residual non-active) or has been malaria free for at least 3 years (cleared).

**Fig. A5.6.** Process of stratification in elimination settings

Source: Adapted from WHO (19).

Stratification has clear benefits for elimination programmes and allows subnational areas to move towards malaria elimination at their own pace (19).

Additional interventions, including intensified surveillance systems, are then defined based on the status of the focus as well as other contextual factors, including the level of population mobility between foci within the country or across borders between countries. Box A5.2 describes an example of stratification in Lao People's Democratic Republic.

## Box A5.2. Country example – Lao People’s Democratic Republic

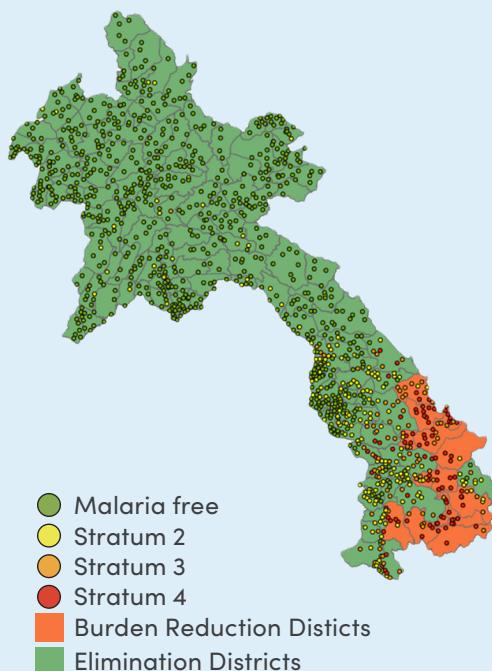
In Lao People’s Democratic Republic, the Center of Malaria, Parasitology and Entomology conducted an epidemiological stratification exercise to define malaria risk at district and health facility catchment area (HFCA) level (20). The exercise was intended to assess progress in malaria control and inform targeting of the limited resources to ensure greatest impact.

The stratification exercise used a combination of routine data for the period 2019–2021, malaria risk maps from predictive models, and consultation with national and subnational experts to classify each of the 148 districts by malaria risk.

HFCAs with zero malaria cases were classed as malaria free, those with 1–4 cases as Stratum 2, those with 5–20 cases as Stratum 3, and those with more than 20 cases as Stratum 4. The case thresholds to define each stratum were based on discussions with experts in the technical working group for stratification.

Of 148 districts, 14 were classified as high-risk districts, where the focus was burden reduction, and the remaining 134 as elimination districts with low risk of malaria. Out of 1235 HFCAs, 88 were classified as highest risk (Stratum 4) and the rest were distributed across other strata.

### District and HFCA level stratification in Lao People’s Democratic Republic, 2022



Source: Vilay et al. (20).

The results of stratification were used to revise the previous intervention strategy and support an accelerated response in the country. For each district, the key goals were defined based on whether it was a burden reduction or elimination district. A set of interventions were then defined for each HFCA stratum.

### Intervention combinations targeted to each stratum in Lao People's Democratic Republic

Strata	Intervention packages
<b>District-level stratification</b>	
<b>Elimination</b>	Surveillance for elimination-case notification, case investigation, case classification, foci investigation, foci response
<b>Burden reduction</b>	Surveillance for control and effective response in areas with increased transmission
<b>HFCA-level stratification</b>	
<b>Malaria free</b>	1. Universal testing and treatment 2. IEC
<b>Stratum 2</b>	1. Universal testing and treatment 2. IEC
<b>Stratum 3</b>	1. Universal testing and treatment 2. IEC 3. Targeted LLIN coverage 4. Targeted VMWs (villages with at-risk populations) 5. Outbreak or foci response (ACD, IRS, entomological surveillance, LLIN top-up, targeted drug administration (TDA) in areas with prolonged outbreaks)
<b>Stratum 4</b>	1. Universal testing and treatment 2. IEC 3. Universal LLIN coverage 4. Universal VMWs 5. Outbreak or foci response (ACD, IRS, entomological surveillance, LLIN top-up, targeted drug administration in areas with prolonged outbreaks) 6. Targeted Mobile Malaria Workers (for high-risk populations staying outside of the village) 7. TDA and intermittent preventative treatment (for high-risk populations during malaria high season in targeted villages)

ACD: active case detection; HFCA: health facility catchment area; IEC: information, education, communication; IRS: indoor residual spraying; ITN: insecticide-treated net; TDA: targeted drug administration; VMW: village malaria workers.

Source: Adapted from Vilay et al. (20).

## References<sup>1</sup>

1. Malaria Atlas Project [website]. Malaria Atlas Project; 2024 (<https://malariaatlas.org/>).
2. Tatem AJ, Adamo S, Bharti N, Burgert CR, Castro M, Dorelien A et al. Mapping populations at risk: improving spatial demographic data for infectious disease modeling and metric derivation. Popul Health Metr. 2012;10(1):8 (<https://doi.org/10.1186/1478-7954-10-8>).
3. World malaria report 2024: addressing inequity in the global malaria response. Geneva: World Health Organization; 2024 (<https://iris.who.int/handle/10665/379751>).

<sup>1</sup> All references were accessed on 11 June 2025.

4. Odhiambo J, Kalinda CM, PM Snow, RW, Sartorius B. Spatial and spatio-temporal methods for mapping malaria risk: a systematic review. *BMJ Glob Health.* 2020;5(10):e003547 (<https://doi.org/10.1136/bmjgh-2020-002919>).
5. Thawer SG, Chacky F, Runge M, Reaves E, Mandike R, Lazaro S et al. Sub-national stratification of malaria risk in mainland Tanzania: a simplified assembly of survey and routine data. *Malar J.* 2020;19:1–13 (<https://doi.org/10.1186/s12936-020-03250-4>).
6. Framework for the allocation of limited malaria vaccine supply. Geneva: World Health Organization; 2022 (<https://www.who.int/publications/m/item/framework-for-allocation-of-limited-malaria-vaccine-supply>).
7. Goodman KHC, Lines J, Meek S, Bradley D, Mills A. The economics of malaria control interventions. London: London School of Hygiene and Tropical Medicine; 2004 ([https://www.researchgate.net/publication/252120760\\_The\\_Economics\\_of\\_Malaria\\_Control\\_Interventions](https://www.researchgate.net/publication/252120760_The_Economics_of_Malaria_Control_Interventions)).
8. Nesbitt RC, Gabrysch S, Laub A, Soremekun S, Manu A, Kirkwood BR et al. Methods to measure potential spatial access to delivery care in low- and middle-income countries: a case study in rural Ghana. *Int J Health Geogr.* 2014;13:25 (<https://doi.org/10.1186/1476-072X-13-25>).
9. Mateusz M, Plucinski, Manzambi Ferreira, Carolina Miguel Ferreira, Jordan Burns, Patrick Gaparayi, Lubaki João et al. Evaluating malaria case management at public health facilities in two provinces in Angola. *Malar J.* 2017;16:186 (<https://doi.org/10.1186/s12936-017-1843-7>).
10. The Alliance for Malaria Prevention: a toolkit for mass distribution campaigns to increase coverage and use of long-lasting insecticide-treated nets, 2nd edition. Geneva: Alliance for Malaria Prevention; 2012 (<https://allianceformalaria-prevention.com/resources/amp-toolkit/toolkit-2-0/>).
11. Seasonal malaria chemoprevention with sulfadoxine–pyrimethamine plus amodiaquine in children: a field guide, 2nd ed. Geneva: World Health Organization; 2023 (<https://iris.who.int/handle/10665/368123>).
12. Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) [online database]. Santa Barbara: Climate Hazards Center, University of California, Santa Barbara; 2025 (<https://www.chc.ucsb.edu/data/chirps>).
13. Cairns M, Roca-Feltrer A, Garske T, Wilson A, Diallo D, Milligan P et al. Estimating the potential public health impact of seasonal malaria chemoprevention in African children. *Nat Commun.* 2012;3(1):881 (<https://doi.org/10.1038/ncomms1879>).
14. Chandramohan D, Zongo I, Sagara I, Cairns M, Yerbanga R-S, Diarra M et al. Seasonal malaria vaccination with or without seasonal malaria chemoprevention. *N Engl J Med.* 2021;385(11):1005–17 (<https://doi.org/10.1056/NEJMoa2026330>).

15. Alassane Dicko, Jean-Bosco Ouedraogo, Issaka Zongo, Issaka Sagara, Matthew Cairns, Rakiswendé Serge Yerbanga et al. Seasonal vaccination with RTS,S/AS01E vaccine with or without seasonal malaria chemoprevention in children up to the age of 5 years in Burkina Faso and Mali: a double-blind, randomised, controlled, phase 3 trial. *Lancet Infect Dis.* 2024;24(1):75–86 ([https://www.thelancet.com/journals/laninf/article/PIIS1473-3099\(23\)00368-7/fulltext](https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(23)00368-7/fulltext)).
16. Guide to introducing malaria vaccines into national immunization programmes. Geneva: World Health Organization; 2025.
17. Global framework for the response to malaria in urban areas. Geneva: World Health Organization; 2022 (<https://iris.who.int/handle/10665/363899>).
18. Jacobson JO, Cueto C, Smith JL, Hwang J, Gosling R, Bennett A. Surveillance and response for high-risk populations: what can malaria elimination programmes learn from the experience of HIV? *Malar J.* 2017;16:33 (<https://doi.org/10.1186/s12936-017-1679-1>).
19. A framework for malaria elimination. Geneva: World Health Organization; 2017 (<https://iris.who.int/handle/10665/254761>).
20. Vilay P, Dunn JC, Sichanthongthip O, Reyburn R, Butphomvihane P, Phiphakavong V et al. Malaria risk stratification in Lao PDR guides program planning in an elimination setting. *Sci Rep.* 2024;14:1709 (<https://doi.org/10.1038/s41598-024-52115-2>).

# Annex 6. Practical considerations for tailoring malaria interventions and strategies

WHO guidelines and resources should be referenced alongside the information in this annex to effectively deploy, tailor to local context and prioritize interventions.

Overarching documents include:

- WHO guidelines for malaria (1)
- WHO manual for elimination scenario planning (2)
- the *Guiding principles for prioritizing malaria interventions in resource-constrained country contexts to achieve maximum impact* (3).

WHO has developed a set of practical digital resources to support countries in planning and implementing service packages for UHC through the Service Package Delivery & Implementation Platform (4). The platform helps countries assess and document current service delivery at national and subnational levels, identify gaps or bottlenecks, and modify packages accordingly. It also enables the contextualization of national service delivery standards for subnational levels or emergency responses, such as mobile health units during crises. The WHO standardized architecture facilitates the integration of malaria-specific services into national UHC packages, ensuring alignment with national priorities and care models. Malaria services should be explicitly defined at all levels of the health system – from community to clinic to hospital – to ensure continuity of care. Additionally, for effective service delivery, it is advisable to clearly define the human and material resource requirements within a UHC package.

Guidance for specific interventions is available from the references cited in the sections below.

## A6.1 Case management

### A6.1.1 Key considerations for deployment of case management

- The provision of prompt diagnosis and effective treatment of all malaria cases and appropriate management of severe malaria are the foundations of malaria control and elimination, irrespective of the malaria transmission intensity.
- Providing prompt access to malaria diagnosis and treatment by maintaining existing services across all levels of the health-care delivery system, including at community level, should be guaranteed for all as a basic human right.

- Information on parasite species, disease severity and costs determine the type of diagnostic test used, usually microscopy and/or RDTs.
- Information on parasite species, therapeutic drug efficacy – along with appropriate formulations – inform the choice of antimalarial drugs for first- and second-line treatment. Implementing multiple first-line strategies, as recommended by WHO, involves deploying multiple ACTs concurrently in different geographical areas or populations to mitigate the spread of resistance and prolong the efficacy of existing treatments. This approach requires careful consideration of local resistance patterns and operational feasibility to ensure optimal outcomes (5, 6).

### A6.1.2 Considerations for tailoring of case management

- Increasing access and reducing inequity – expand effective malaria case management to underserved populations via new PHC units, services such as CHWs, prereferral treatment or inpatient services. Expansion decisions typically involve broader ministry of health entities, with malaria programme investments potentially facilitating resources such as commodities.
- Ensuring consistent supply – Reliable provision of case management commodities is usually managed by a separate department within the ministry of health, with disease programmes assisting in quantification, funding, stock monitoring, and supply chain development. Strong collaboration between NMPs and supply chain departments is crucial.
- Improving quality of care – NMPs play a key role in developing guidelines, training, performance assessments, supervision, social and behaviour change communication activities for compliance, diagnosis quality assurance and pharmacovigilance.
- Engaging the private sector – many malaria patients, especially in urban areas, rely on the private sector, where quality and coverage improvements are needed.
- Special population groups – special populations, such as travellers from non-endemic settings, may require prophylaxis during travel to endemic areas.

### A6.1.3 Considerations for prioritization of case management under resource constraints

Scaling back access to early diagnosis and treatment is not an option under any level of financial constraint. Processes funded by the broader health system (e.g. training, supervision, quality assurance of diagnostics, supply chain management or funding malaria-specific processes) should be leveraged for routine case management. The SNT process should use information about resource constraints in its decision-making, including for decisions relating to:

- expanding access to care versus improving quality of care;
- implementing prereferral treatment of severe malaria by all CHWs in all endemic areas versus targeting remote communities with high disease burden;

- Phased implementation of G6PD testing and antirelapse treatment in all vivax endemic areas versus targeted introduction and expansion of G6PD testing and antirelapse treatment in areas with high burden of *P. vivax* malaria;
- providing subsidies on quality-assured malaria medicines and diagnostics for the private sector versus expanding quality of care through PHC services; and
- targeting of mobile and migrant populations with outreach case management services versus investing in improving overall case management in health facilities.

## A6.2 Vector control

Effective tailoring of vector control interventions requires a good understanding of vector species, behaviour, habitats and distribution. Different species of *Anopheles* mosquitoes have their own preferred aquatic habitats; for example, some prefer small, shallow collections of fresh water, such as puddles and animal hoof prints, whereas others prefer large, open water bodies, including lakes, swamps and rice fields.

Different mosquito species demonstrate preferences for feeding on animals (zoophily) or on humans (anthropophily); however, these preferences are not absolute, and females may take a blood meal from nonpreferred hosts when these are present in the area. Blood feeding can take place inside human habitations (endophagy) or outdoors (exophagy), depending on the mosquito species. These behaviours are often not exclusive – some mosquitoes will feed indoors and outdoors, and others may feed on animals and humans.

The geographical distribution of the vectors, their feeding and resting behaviours, and their susceptibility to insecticides have implications for the selection and effectiveness of vector control interventions.

### A6.2.1 Insecticide-treated nets (ITNs)

#### A6.2.1.1 Key considerations for deployment of ITNs

- If pyrethroid resistance is detected, next-generation ITNs should be considered for distribution, instead of pyrethroid-only nets (7).
- ITNs are most effective where the principal malaria vector(s) bites predominantly at night – when people will be sleeping, protected under their nets.
- ITNs can be used both indoors and outdoors, wherever they can be suitably hung (but hanging nets in direct sunlight should be avoided).
- Continuous distribution through ANC and EPI channels should remain functional before, during and after mass distribution campaigns. Other distribution channels may include schools, faith- and community-based networks, and occupation-related channels (e.g. to farm workers, miners).
- Digital microplanning and delivery platforms can be efficient tools for targeting and distribution of nets (8). Post-distribution monitoring of ITNs is essential, reporting their durability, usage and coverage.

- Programmatic, routine and household survey data are useful to keep track of access, coverage and use of ITNs.

#### A6.2.1.2 Considerations for tailoring of ITNs

- ITNs are recommended for use at any level of malaria endemicity. In practice, their effectiveness is determined by the underlying transmission intensity, among other factors.
- For operational purposes, the transmission threshold of > 1% *P. falciparum* parasite prevalence (usually in children aged 2–10 years;  $PfPR_{2-10}$ ) is a useful threshold for identifying endemic areas at the subnational level.
- In some settings, such as in elimination areas or humanitarian emergency situations, ITNs may be targeted at a specific high-risk population group in which individual protection is the priority. Transmission thresholds may not apply in such circumstances.
- In urban areas general infrastructure development and improvement in housing may modify malaria receptivity and/or provide protection against mosquitoes (9). These factors typically result in highly clustered malaria transmission patterns. Available data should be used to identify clusters of malaria transmission (microstratification) to decide if and where to distribute ITNs, if appropriate and acceptable to the community.

#### A6.2.1.3 Considerations for prioritization of ITN scale-up under resource constraints

- Where resources are limited, ITNs should be targeted at areas of highest need (e.g. high transmission intensity). For example, countries may increase the threshold for targeting ITNs to exclude areas of very low preintervention transmission, especially if such areas have adequate access to effective case management.
- Even within areas of moderate and high transmission, there will be communities that are disproportionately underserved, more at risk and where the burden of mortality is highest. Ensuring these populations are protected first from malaria transmission is likely to lead to higher impact per amount of resources invested.
- Where a decision is needed on targeting of more efficacious and expensive next-generation ITNs, the highest burden areas, especially those with highest risk of transmission and mortality due to malaria, should be prioritized. Such decisions should be supported, where possible, with information on insecticide resistance.
- The urban microstratification process can be further refined to define areas of relatively high malaria transmission and low socioeconomic status, and prioritize such areas for ITN distribution.
- Special attention should be paid to displaced populations and other groups in humanitarian emergencies, even in areas of low malaria transmission, as they are highly vulnerable to the consequences of infection and may also be a source of onward transmission.

## A6.2.2 Indoor residual spraying (IRS)

### A6.2.2.1 Key considerations for deployment of IRS

- Detailed information on IRS implementation is available in the WHO operational manual on IRS (10).
- IRS is considered an appropriate intervention where:
  - most of the vector population feeds and rests indoors;
  - people mainly sleep indoors at night;
  - the malaria transmission pattern is such that the population can be protected by one or two rounds of IRS per year; and
  - the majority of structures are suitable for spraying.
- It is important to use information on the insecticide resistance profile of the local vectors to ensure selection of insecticides to which the vectors are susceptible.
- Community acceptance of IRS is critical to the programme's success, especially given it requires householders to grant permission for spray teams to enter their house. It also involves disruption to the household, requiring householders to remove personal items from their house prior to spraying.
- The co-deployment of ITNs and IRS is not recommended for prevention and control of malaria in children and adults in areas with ongoing malaria transmission (1). Countries should focus on achieving high coverage for one or the other, guided by the appropriate allocation of limited resources. Additionally, IRS enables easier rotation of insecticides (compared to ITNs) to manage resistance.

### A6.2.2.2 Considerations for tailoring of IRS

- IRS should be targeted to areas where the heavy logistic demands of IRS are operationally feasible (e.g. places with good road connectivity).

### A6.2.2.3 Considerations for prioritization of IRS under resource constraints

- Urban communities are likely to have the lowest levels of IRS acceptance. Also, most urban areas in malaria endemic countries generally have lower malaria transmission than rural areas. Careful assessment of acceptance, impact and relative effect of other vector control interventions, such as LSM and house screening, is required before considering IRS for urban settings.
- In rural areas, the choice should be based on an analysis comparing the impact and cost-effectiveness of IRS versus high levels of ITN coverage in the same setting.

## A6.2.3 Larval source management (LSM)

LSM in the context of malaria control is the management of water bodies that are potential larval habitats for mosquitoes. Such management of water bodies is conducted to prevent the development of the immature stages (eggs, larvae and pupae) and hence the production of adult mosquitoes, with the overall aim of preventing or controlling transmission of malaria. There are four types of LSM:

- habitat modification – a permanent alteration to the environment (e.g. land reclamation, filling of water bodies);
- habitat manipulation – a recurrent activity (e.g. flushing of streams, drain clearance);
- larvicing – the regular application of biological or chemical insecticides to water bodies; and
- biological control – the introduction of natural predators into water bodies.

#### A6.2.3.1 Key considerations for deployment of larvicing

- Larvicing can be used as a supplementary intervention to ITNs or IRS in areas with ongoing malaria transmission where aquatic habitats are few, fixed and findable (11).
- Mapping of larval habitats requires geospatial entomological surveillance capabilities.
- Examples of such ecologies include urban areas where malaria transmission is clustered and breeding sites are close to houses, and arid areas where larval habitats may be few and fixed throughout much of the year.

#### A6.2.3.2 Considerations for tailoring of larvicing

- Larvicing should be targeted to areas where malaria transmission is low, not generalized and there are identifiable clusters (hot spots) of malaria transmission (e.g. in urban areas).
- Sufficient capacity is required to operationalize and monitor the coverage, quality and impact of larvicing.

#### A6.2.3.3 Considerations for prioritization of larvicing under resource constraints

- Malaria response may be integrated with ongoing larvicing for control of other vector-borne diseases, such as dengue and Zika virus in urban areas.
- Communities can be leveraged to participate in the surveillance of larval habitats and the implementation of larvicing.

### A6.2.4 Additional vector control interventions

Additional interventions e.g. house screening may be considered, and WHO has issued a recommendation suggesting the use of screening of residential houses for the prevention and control of malaria in children and adults in areas with ongoing malaria transmission (1, 12). This recommendation addresses the screening of windows, ceilings, doors and/or eave spaces. It does not cover other ways of blocking entry points into houses. Screening of houses is also likely to be beneficial for the control of other vectors, especially in urban settings, and could be implemented as part of a broader public health strategy. This would require multisectoral collaboration. Additional information can be found in the WHO framework for response to malaria in urban settings (13).

## A6.3 Chemoprevention

### A6.3.1 Intermittent preventive treatment of malaria in pregnancy (IPTp)

#### A6.3.1.1 Key considerations for deployment of IPTp (including choice of drugs)

In malaria endemic areas, pregnant women of all gravitudes should be given antimalarial medicine at predetermined intervals to reduce disease burden in pregnancy and adverse pregnancy and birth outcomes (1).

- SP has been widely used for malaria chemoprevention during pregnancy and remains effective in improving key pregnancy outcomes.
- Doses of SP should be given at least 1 month apart, with the objective of ensuring that at least three doses are received.
- ANC contacts remain an important platform for delivering IPTp. WHO recommends a minimum of eight ANC contacts during pregnancy, providing multiple opportunities to administer IPTp.
- Community distribution offers an opportunity to minimize missed opportunities and/or serve populations with limited access to health facilities (14).
- IPTp is generally highly cost-effective, widely accepted and feasible for delivery.

#### A6.3.1.2 Key considerations for tailoring of IPTp

- Outreach approaches to IPTp delivery (e.g. through CHWs) may provide opportunities to increase coverage while supporting continued ANC attendance.
- Consideration should be given to contextual factors such as the values and preferences of end users, costs, coverage, and sustainability of PHC services at community level.

#### A6.3.1.3 Considerations for prioritization of IPTp under resource constraints

- Existing delivery mechanisms and outreach activities may be leveraged to maintain ANC or introduce community-based IPTp services.

### A6.3.2 Perennial malaria chemoprevention (PMC)

PMC is the administration of a full treatment course of an antimalarial medicine to children at predefined intervals, regardless of whether the child is infected with malaria, to prevent illness in moderate to high perennial malaria transmission settings.

#### A6.3.2.1 Key considerations for deployment of PMC

- PMC is suitable to protect children at risk of severe malaria in areas with moderate to high perennial malaria transmission settings.
- Schedules should be informed by the age pattern of severe malaria admissions, the duration of protection of the selected drug, and the feasibility and affordability of delivering each additional PMC course.

- SP has been the most widely used antimalarial medicine for PMC. ACTs have been effective in PMC trials, but their use for chemoprevention is limited.
- Previously, PMC was recommended as intermittent preventive treatment in infants (< 12 months of age; IPTi) (15). Since the initial recommendation, new data has documented the value of malaria chemoprevention in children aged 12–24 months (1).

#### A6.3.2.2 Key considerations for tailoring of PMC

- The EPI platform remains important for delivering PMC. Other methods of delivery can be explored to optimize access to PMC and integration with other health interventions.
- Consideration should be given to contextual factors for the delivery of PMC (e.g. preferences of end users, costs, coverage and sustainability of PHC services).

#### A6.3.2.3 Key considerations for prioritization of PMC under resource constraints

- Phase the scale-up of PMC where expansion of PMC is under consideration.
- Leverage existing delivery mechanisms and outreach activities to maintain care services delivering PMC.
- Scale back PMC in urban areas and/or in other areas with strong access to prompt and effective case management and community referral systems.

#### A6.3.3 Seasonal malaria chemoprevention (SMC)

SMC is recommended in areas of seasonal malaria transmission, for children belonging to age groups at high risk of severe malaria. They should be given antimalarial medicines (SP+AQ) during the peak malaria transmission seasons to reduce disease burden.

Detailed information on SMC implementation is provided in the WHO SMC field guide (16). The following information has been extracted from the guide and summarized to help inform SNT for SMC.

#### A6.3.3.1 Key considerations for deployment of SMC

- SMC is primarily recommended for children aged 3–59 months (i.e. under 5 years) in areas of highly seasonal malaria transmission.
- SP and the first dose of AQ should be taken on the first day of treatment, under directly observed therapy (DOT1). The second and third doses of AQ should be given over the next 2 days by the caregiver.
- Caregiver adherence to the 3-day regimen can be reinforced through appropriate care-giver counselling and community engagement.
- A mechanism is needed for children who are sick at the time of the campaign to be referred to a qualified health worker for testing. All children with a positive test should receive a full ACT curative treatment. This could be administered at a health facility or, where appropriate, by a CHW.

- Pharmacovigilance should be strengthened where it exists and should be instituted where it does not.
- Drug resistance monitoring through the malaria chemoprevention efficacy study protocol (17) is needed to evaluate the protective effect of SP+AQ for SMC.

#### A6.3.3.2 Key considerations for tailoring of SMC

- Areas that meet the criteria of high seasonality and transmission intensity for SMC eligibility must be defined.
- The age range of children to be targeted must be defined based on the patterns of severe disease by age, requiring disaggregation of data above 5 years of age.
- Implementation logistics must comply with the requirements for deployment, as described in the previous section.

#### A6.3.3.3 Considerations for prioritization of SMC under resource constraints

- Phase the scale-up of SMC where expansion of SMC is under consideration.
- Reassess demographics and geographical eligibility criteria based on evidence.
- Continue to target children under the age of 5 years instead of expanding to children aged over 5 years, even if evidence shows shifting severe disease patterns.
- If DOT3 is used for all doses, scale back to DOT1.
- Adjustment may include scaling back SMC in urban areas and/or scaling back the number of cycles where appropriate (e.g. from five to four, if five cycles had been implemented).

#### A6.3.4 Additional chemoprevention interventions

Other chemoprevention interventions such as mass drug administration (MDA), post-discharge malaria chemoprevention (PDMC) and intermittent preventive treatment in school-aged children (IPTsc) can reduce malaria burden in specific high-risk contexts but require careful consideration before deployment.

- MDA may offer short-term reductions in transmission or burden in low transmission or emergency settings, but is rarely routine due to operational complexity and limited sustainability.
- PDMC targets children under 5 years of age after hospitalization for severe malarial anaemia, providing monthly preventive treatment during a high-risk period, and should be prioritized in districts with high severe malaria admissions.
- IPTsc addresses malaria in school-aged children who represent a significant infection reservoir, requiring alignment with school platforms and targeting areas with high prevalence.

For all three interventions, suitability, feasibility and resource availability should be carefully assessed to ensure integration into broader, robust malaria programmes and avoid undermining other critical interventions.

## A6.4 Vaccines

The RTS,S/AS01 and the R21/MatrixM vaccines are the two WHO-recommended vaccines to prevent *P. falciparum* malaria in children (18, 19). Malaria vaccines should be provided in a four-dose schedule to children from 5 months of age. The fourth dose is provided during the second year of life to prolong protection. In some areas, where malaria risk continues into the third year of life, a fifth dose can be provided 12 months after the fourth. The vaccine can be provided using an age-based approach, a seasonal approach with doses given prior to the peak transmission season, or a hybrid of the two with the first three doses provided from 5 months of age and subsequent doses provided just prior to the peak seasons.

### A6.4.1 Considerations for deployment of vaccines

- Malaria vaccines are recommended for the prevention of *P. falciparum* malaria in children living in malaria endemic areas, prioritizing areas of moderate and high transmission.
- Decisions on expanding to low transmission settings should be considered at the country level, considering overall malaria control strategy, affordability, cost-effectiveness, and programmatic considerations such as whether inclusion of such areas would simplify delivery.
- Vaccine introduction should be considered in the context of a comprehensive national malaria control strategy.
- Decision-making on the adoption and implementation of the malaria vaccine should be in close collaboration with the NMP, EPI and other relevant ministry of health departments. The malaria vaccine, if adopted, should be integrated into relevant immunization guidelines and malaria strategic plans. Generally, the country's national immunization programme leads the logistics of vaccine rollout and delivery to relevant health facilities. The NMP supports vaccine guideline development and SNT of the vaccine (i.e. where the vaccine should be implemented).
- Like all malaria prevention tools, the malaria vaccine should be provided as part of a combination of malaria interventions.
- Countries that choose to introduce the vaccine in a five-dose seasonal strategy are encouraged to document their experiences, including monitoring adverse events following immunization. The primary series of three doses should be provided at monthly intervals using an age-based approach, with additional doses provided annually prior to the start of the peak transmission season.
- The new child immunization visits to provide malaria vaccines are opportunities to provide other child health services, including to deliver PMC, provide messages regarding malaria prevention, catch up on missed vaccinations, administer vitamin A and carry out deworming.

## A6.4.2 Considerations for tailoring of vaccines

- Targeting seasonal vaccine delivery in areas of highly seasonal malaria.
- Consider providing a fifth dose of malaria vaccine if risk of severe malaria and mortality persists in the third year of life.

## A6.4.3 Considerations for prioritization of vaccines under resource constraints

- Areas of moderate and high transmission should be prioritized.
- Considerations for further prioritization could include malaria burden and epidemiology (including severe malaria and/or mortality), overall malaria control strategy, and the ability to achieve high uptake, acceptability and equity.

## References<sup>1</sup>

1. WHO guidelines for malaria [website]. World Health Organization; 2024 (<https://app.magicapp.org/#/guideline/LwRMXj>).
2. From malaria control to malaria elimination: a manual for elimination scenario planning. Geneva: World Health Organization; 2014 (<https://iris.who.int/handle/10665/112485>).
3. Guiding principles for prioritizing malaria interventions in resource-constrained country contexts to achieve maximum impact. Geneva: World Health Organization; 2024 (<https://doi.org/10.2471/B09044>).
4. Build and implement UHC packages with SPDI [website]. World Health Organization; (<https://uhcc.who.int/uhcpackages/>).
5. Multiple first-line therapies as part of the response to antimalarial drug resistance: an implementation guide. Geneva: World Health Organization; 2024 (<https://iris.who.int/handle/10665/379576>).
6. Strategy to respond to antimalarial drug resistance in Africa. Geneva: World Health Organization; 2022 (<https://iris.who.int/handle/10665/364531>).
7. Conditions for deployment of mosquito nets treated with a pyrethroid and piperonyl butoxide: recommendations. Geneva: World Health Organization; 2017 (<https://iris.who.int/handle/10665/258939>).
8. Khan J, Mubiru D, Chestnutt EG, Cook L, Lual Riiny L, Okot F et al. Usability of a digital tool to support long-lasting insecticide net distribution in Northern Bahr el Ghazal State, South Sudan. *Malar J*. 2024;23:318 (<https://doi.org/10.1186/s12936-024-05092-w>).

<sup>1</sup> All references were accessed on 11 June 2025.

9. Carter R, Karunaweera ND. The role of improved housing and living environments in malaria control and elimination. *Malar J.* 2020;19:385 (<https://doi.org/10.1186/s12936-020-03450-y>).
10. Operational manual on indoor residual spraying: control of vectors of malaria, Aedes-borne diseases, Chagas disease, leishmaniases and lymphatic filariasis. Geneva: World Health Organization; 2023 (<https://iris.who.int/handle/10665/375978>).
11. Larval source management: a supplementary malaria vector control measure – an operational manual. Geneva: World Health Organization; 2013 (<https://iris.who.int/handle/10665/85379>).
12. WHO housing and health guidelines. Geneva: World Health Organization; 2018 (<https://iris.who.int/handle/10665/276001>).
13. Global framework for the response to malaria in urban areas. Geneva: World Health Organization; 2022 (<https://iris.who.int/handle/10665/363899>).
14. Community deployment of intermittent preventive treatment of malaria in pregnancy with sulfadoxine-pyrimethamine: a field guide. Geneva: World Health Organization; 2024 (<https://iris.who.int/handle/10665/375714>).
15. Intermittent preventive treatment for infants using sulfadoxine-pyrimethamine (SP-IPTi) for malaria control in Africa: implementation field guide. Geneva: World Health Organization; 2011 (<https://iris.who.int/handle/10665/70736>).
16. Seasonal malaria chemoprevention with sulfadoxine-pyrimethamine plus amodiaquine in children: a field guide, 2nd ed. Geneva: World Health Organization; 2023 (<https://iris.who.int/handle/10665/368123>).
17. Malaria chemoprevention efficacy study protocol. Geneva: World Health Organization; 2022 (<https://iris.who.int/handle/10665/360908>).
18. Malaria vaccine implementation programme [website]. World Health Organization; 2024 (<https://www.who.int/initiatives/malaria-vaccine-implementation-programme>).
19. World Health Organization. Malaria vaccines: WHO position paper. *Weekly Epidemiological Record*. 2024;99(19):225–48 (<https://iris.who.int/handle/10665/376739>).

# Annex 7. Mathematical modelling

Mathematical models, also known as dynamical models or transmission models, use mathematical equations to capture key mechanisms of malaria transmission and disease, including the vector life cycle, transmission between humans and vectors, acquisition of immunity and development of symptoms. These models can simulate the impact of various interventions. To be appropriate for use in an SNT context, the model must:

- be capable of generating outcomes of interest to the NMP, such as symptomatic cases or deaths, for populations of interest to the NMP, such as children under 5 years of age or the entire population;
- be capable of incorporating interventions of interest to the NMP and credibly reproducing the expected effect size of those interventions;
- be capable of reproducing the malaria transmission context of the country (e.g. credibly reproducing local prevalence, incidence and seasonality of malaria); and
- credibly reproduce basic epidemiological relationships, such as the relationships between prevalence or incidence with age or exposure, to demonstrate that acquisition of immunity and basic transmission features are well captured.

Models that meet these criteria can be complex, requiring many parameters. Ideally, parameter values are informed by country data, but when directly measured data are not available, parameter values are either inferred (the parameter value is selected such that the model outputs are consistent with reality) or assumed. Key model assumptions should be made clear and reviewed with the NMP and technical partners to determine their acceptability.

## A7.1 Use of mathematical models

Mathematical models can serve different use cases to inform malaria strategic and operational planning (e.g. understand disease dynamics, simulate the emergence or spread of biological threats such as drug resistance, evaluate impact of interventions prospectively or retrospectively, inform resources allocation). Specifically in the context of SNT, they can be used to iteratively inform the combination of interventions and predict its impact on malaria transmission compared with a business-as-usual intervention scenario (counterfactual). The outputs of the models include cases averted, deaths averted, and changes in prevalence attributable to the tested intervention scenario compared to the baseline.

Models can be used by NMPs to simulate the impact of a new strategic plan compared to the previously implemented combination of interventions; to simulate the impact of changing individual interventions, for example rollout of malaria vaccine versus extension of SMC eligibility; to simulate the impact of increasing geographical or demographic coverage of individual or multiple interventions; to attribute the impact of a past intervention by comparing against a counterfactual scenario where that intervention had not been implemented; and to simulate the most impactful strategies for a given budget (See Annex 8).

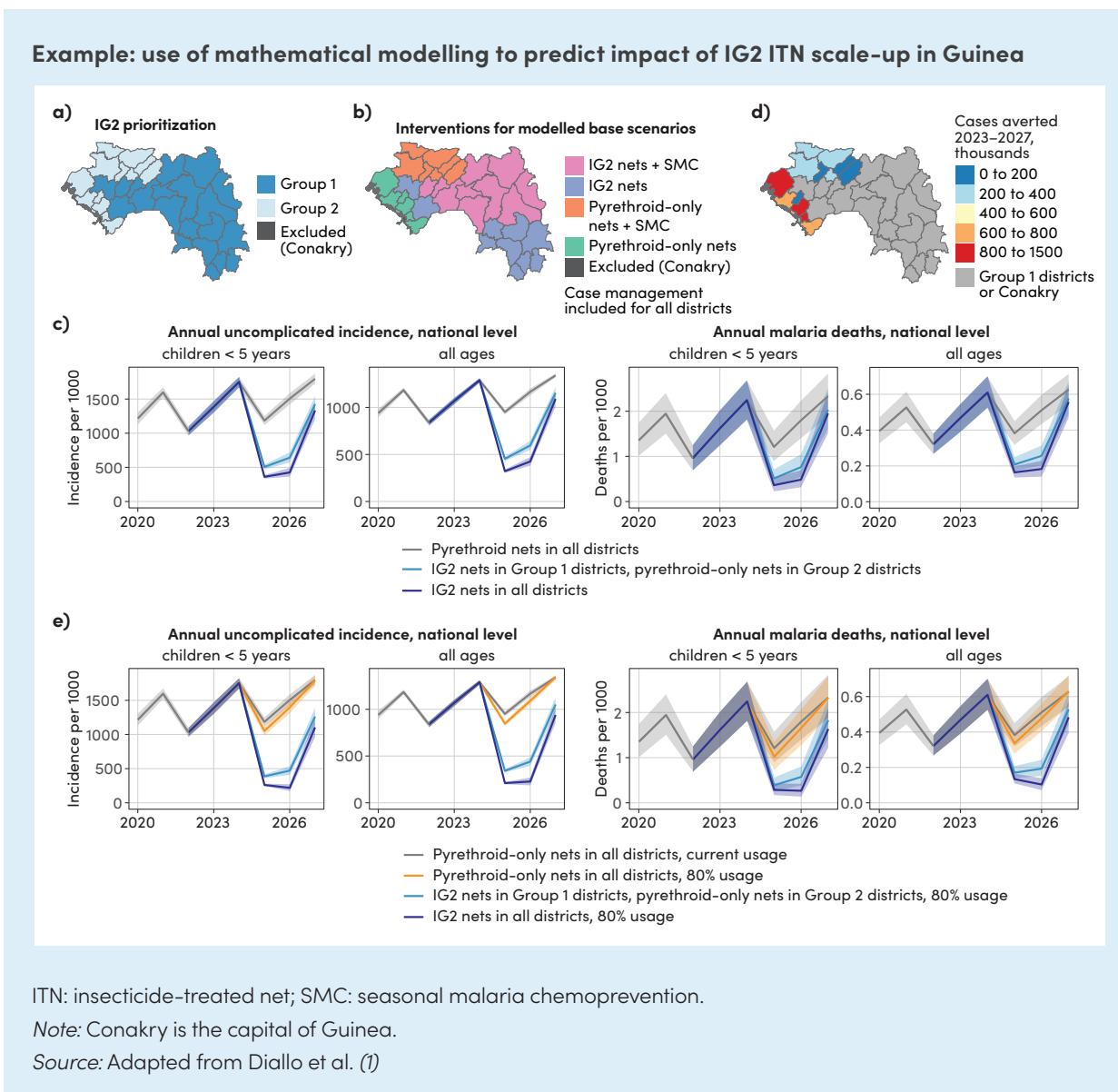
An example of the use of mathematical models is described in Box A7.1.

### Box A7.1. Example – use of mathematical models

The NMP of Guinea was interested in assessing the potential impact of scale-up of IG2 ITNs in priority areas (Group 1) that had been selected in previous steps of the SNT approach (panel a of the figure). They wanted to evaluate the impact of scale-up in Group 1 districts (panel b) compared with 1) no scale-up, where pyrethroid-only ITNs were distributed in all districts; 2) IG2 ITNs distributed in all districts; and 3) pyrethroid-only ITNs distributed in all districts but with ITN utilization reaching 80%.

A mathematical model was constructed for each district in Guinea, using local prevalence and incidence data to set transmission intensity and seasonality (20). All malaria interventions previously implemented were included in the model. The scenario that includes case management, SMC where eligible, and the target ITN distribution scheme is shown in panel b of the figure.

Simulations of the scenarios of interest were produced to cover the next 3 years (panel c). Cases averted for children under 5 years of age and for all ages were generated, compared with the baseline scenario of pyrethroid-only ITNs under current utilization rates (panel d). IG2 ITN distribution was projected to significantly reduce cases and deaths across all age groups. When distributed in all districts, it was expected to achieve even greater reductions compared with Group 1 districts alone (see the figure).



## A7.2 Interpreting mathematical model results

Mathematical models are valuable tools for guiding malaria programme decisions. They provide quantitative insights into potential intervention impacts depending on country context, including the level of malaria endemicity. While these models include inherent uncertainties (see section A7.3), their true strength lies in enabling the comparison of relative differences across scenarios, helping programmes prioritize strategies effectively. NMPs are encouraged to interpret results qualitatively, focusing on scenario rankings and trends rather than absolute impacts, and validate predictions against real-world outcomes as data become available.

Model results that differ from expectations present an opportunity for NMPs and partners to understand and refine assumptions, improve data inputs and ensure alignment with performance benchmarks. Whenever possible, local data should be incorporated to parameterize the model, as findings from one setting may not be

generalizable to another. This entails integrating country-specific epidemiological parameters and utilizing data from intervention trials conducted within the target population to enhance the model's applicability and accuracy.

While modelling is a valuable tool, its outputs should not be considered definitive. Its outputs must be interpreted alongside other data and expert insights to inform decision-making.

## A7.3 Limitations of mathematical models

While mathematical models are excellent tools to predict potential intervention impact, which is key for scenario comparisons, they still have important limitations, some of the most important of which are described below.

- **Model structure.** Malaria is a complex phenomenon, with intricate dynamics involving the parasite, vector and human hosts, and their interactions. Models are simplifications of reality – even those that perform realistically in most situations may have limitations or inaccuracies in others. Different models may be needed for different situations, depending on factors such as transmission intensity, intervention responses and age groups. Ideally, a model used in SNT should be validated to ensure it performs reliably in the relevant transmission contexts and addresses the programmatic questions for which it is applied.
- **Intervention effect sizes.** Models may calibrate their intervention efficacy to clinical trial data, but many factors impact intervention effectiveness during implementation. Data are often not available to adequately inform the model on those factors, which include intervention coverage, intervention adherence, vector behaviour and health system quality. Models therefore often rely on estimates and assumptions, leading to uncertainty in modelled intervention effectiveness and thus intervention impact predictions. Whenever possible, local data from intervention trials conducted in the country of interest should be used to parameterize the model applied to that specific setting.
- **Availability of epidemiological data.** The models should be parameterized at the level of operational unit at which the NMP is making decisions. However, reliable prevalence and incidence data are not always available at that level. The baseline and current malaria risks are fundamental characteristics of the models, but if data are lacking to reliably represent those risks, the model may inherently carry large uncertainties. Furthermore, other important parameters to inform burden predictions, such as case fatality rate and malaria mortality rate, may not exist at the country level, much less subnationally. Models may therefore need to rely on estimates generated from external sources or other operational units within the country, or data available at broader spatial level that is then disaggregated to finer spatial units.

These limitations can be mitigated by:

- carefully selecting the appropriate level of detail in the model (e.g. incorporating immunity and age structure when assessing vaccine impact);
- validating the model with relevant data (e.g. reproducing historical trends or intervention efficacy in controlled settings);
- comparing multiple models (see section A7.4); and
- clearly communicating uncertainties (e.g. through sensitivity analyses to identify key impact drivers, by visualizing and explaining uncertainty around estimates, by interpreting models results qualitatively instead of quantitatively).

Additionally, geospatial modelling, which integrates epidemiological data from external sources such as neighbouring regions or historical trends, can sometimes help address gaps caused by missing or unreliable reported data.

## A7.4 Use of multiple models

An ideal way to address model limitations is to use multiple models when generating estimates of relative impact. Considering results from multiple models provides a more robust assessment of potential intervention impact, as it incorporates a range of reasonable assumptions and better accounts for uncertainties inherent in each model. This approach is commonly used for climate change forecasts and has also been used for COVID-19 scenario modelling and for global malaria recommendations (2,3).

There are several ways to consider outputs from multiple models. At a minimum, each model can rank the impact of the proposed intervention combinations, and consistencies and inconsistencies in the rankings across models can be assessed. More formally, ensemble modelling can be used to quantitatively integrate outputs from multiple models and produce a combined mean estimate and associated uncertainty. If ensemble modelling is to be undertaken, models must be sufficiently aligned such that their outputs can be quantitatively combined. For example, they should report the same outcome indicator in the same population at the same time point. Reasons for differences in rankings, or interpretation of ensemble modelling outputs, should be discussed with NMPs so they can make an overall determination of the combined model results.

While employing multiple models may enhance robustness, it is often a complex, resource-intensive and time-consuming process, which may limit its feasibility for programmatic support in SNT. Efforts could, instead, be directed towards systematically collating and integrating local data, critically evaluating the strengths and limitations of individual models, and analysing methodological differences across modelling approaches to enhance interpretability and applicability.

## References<sup>1</sup>

1. Diallo OODA, Diakité KBTN, Dioubaté M, Runge M, Symons T, Diallo EM et al. Subnational tailoring of malaria interventions to prioritize the malaria response in Guinea. *Malar J.* 2024;24(1):62 (<https://doi.org/10.1186/s12936-025-05302-z>).
2. Brady OJ, Slater HC, Peter, Pemberton-Ross, Wenger E, Maude RJ et al. Role of mass drug administration in elimination of *Plasmodium falciparum* malaria: a consensus modelling study. *Lancet Glob Health.* 2017;5(7):E680–7 ([https://www.thelancet.com/journals/langlo/article/PIIS2214-109X\(17\)30220-6/fulltext](https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(17)30220-6/fulltext)).
3. Penny MA, Verity R, Bever CA, Sauboin C, Galaktionova K, Flasche S et al. Public health impact and cost-effectiveness of the RTS,S/AS01 malaria vaccine: a systematic comparison of predictions from four mathematical models. *Lancet.* 2016;387(10016):367–75 ([https://doi.org/10.1016/s0140-6736\(15\)00725-4](https://doi.org/10.1016/s0140-6736(15)00725-4)).

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<sup>1</sup> All references were accessed on 11 June 2025.

# Annex 8. SNT costing support

Costing within the SNT process should progress from high-level to more-detailed approaches as intervention planning progresses. At early stage, gross costing, using unit costs per person per year, is typically sufficient to explore feasibility, compare intervention options, and eliminate combinations that are likely to be unaffordable. When combined with modelled or observed impact data and literature on cost-effectiveness, this approach supports decisions on intervention selection, demographic targeting and product choice. As intervention plans become more defined and implementation realities come into view, more-detailed activity-based micro costing is needed. This involves breaking costs down to the resource level by quantifying inputs and applying unit costs (e.g. per diems for 20 people × 5 days × \$10 per person per day = \$1000).

Costing should remain responsive to evolving decision needs. Broad questions, such as which combinations of interventions are most impactful under budget constraints, will give way to more specific trade-offs (e.g. fewer high-cost nets versus broader standard net coverage). The goal is to inform key decisions on intervention design, targeting and financing, and to support the development of realistic, fundable budgets. To be effective, costing must be both technically sound and grounded in meaningful stakeholder engagement. This requires national capacity in key skills such as quantitative analysis, financial modelling, budgeting, and the use of costing tools such as Microsoft Excel. It also requires continuous input from stakeholders, particularly those closest to implementation, to ensure assumptions are realistic, data are validated and outputs are accessible for decision-making. Costing should reflect the needs of diverse populations, account for uncertainty and consider which cost elements may transition to domestic financing over time.

## A8.1 Data requirements for SNT costing

Data required for costing include:

- the time frame to be costed (e.g. NMSP period, grant duration);
- interventions decisions and target coverage at the operational unit level;
- population estimates and population projections at the operational unit level;
- the percentage of the population of each operational unit that meet the per person eligibility criteria for each intervention (e.g. age cut-offs);
- intervention-specific quantification and unit costs, including:
  - cost and quantity of commodities (including buffer stock quantification);
  - procurement and supply chain costs associated with acquiring those commodities;
  - in-country distribution of commodities (e.g. last-mile distribution);
  - implementation for each intervention (e.g. macroplanning, microplanning, training, monitoring and evaluation, supervision, coordination, public communication).

When gathering data for intervention-specific quantification and unit costs, the hierarchy of sources must be considered. Preference should be given to data that are more recent, more granular and closest to what was used during past implementation (Table A8.1).

**Table A8.1.** Hierarchy of costing data sources

Data sources (from ideal to basic)	Example
<b>Past/actual programme expenditure</b>	Government and/or implementing partner expenditure reports, purchase orders
<b>Detailed planning documents</b>	Microplanning, including detailed quantification of resources needed and associated costs
<b>Budgets seeking funding</b>	Budgets submitted to funders (e.g. government, Global Fund), including resource quantification and costs
<b>Macroplanning information</b>	Operational plans or standard operating procedures that provide guidance on resource quantification
<b>General costing</b>	Detailed activity-based costing of current national strategic plan, even if not fully funded
<b>Literature</b>	Research studies, pilots

When gathering resource-level data, the data points listed in Table A8.2 should be included.

**Table A8.2.** Costing data points

Data points	Example
<b>Resources needed</b>	Per diems
<b>Quantity of resources needed</b>	5 days per person
<b>Frequencies at which resources are used</b>	Twice annually
<b>Unit costs of resources</b>	\$10 per person per day

## A8.2 Calculation of costs

For an initial gross costing, costs are typically calculated with disaggregation across three different dimensions: operational unit, time and intervention (Table A8.3).

**Table A8.3.** Disaggregation of costs by operational unit, time and intervention

Operational unit	Year 1			Year 2		
	Mass ITN campaign	IRS	SMC	Mass ITN campaign	IRS	SMC
<b>District 1</b>						
<b>District 2</b>						
<b>District 3</b>						

In its simplest form, the calculation of the cost of each cell (C) in Table A8.3 is the unit-level cost of delivering an intervention (U) multiplied by the quantity of the intervention (Q).

$$C = U \times Q$$

The unit-level cost of delivering an intervention can either be derived top-down using an existing total cost<sup>1</sup> or constructed from the bottom up using an ingredients-based costing approach.<sup>2</sup> Unit costs are sometimes expressed in terms other than per person costs. For example, the unit cost of IRS is often expressed in terms of cost per household sprayed and ITNs can be expressed in terms of cost per net delivered. It is important when using the scaling costing approach to express these unit costs in terms of the cost per person per year.<sup>3</sup> The selection of data used to calculate these costs should be informed by the hierarchy of sources listed in Table A8.1.

The quantity of the intervention (Q) is the product of the target coverage rate of the eligible population (Cov) and the eligible population in that year for that operational unit for the intervention being calculated (Pop).<sup>4</sup>

$$Q = Cov \times Pop$$

Once the costs of each cell (C) in Table A8.3 are calculated, these individual costs should be aggregated to derive subtotal costs by operational unit, intervention and year, and the grand total cost of the full package of interventions.

## A8.3 Costing a selected combination of interventions

Once total costs have been calculated, they can be further analysed by administrative level (e.g. province or district), intervention type (e.g. vector control versus chemoprevention), or funding source (e.g. government, The Global Fund to Fight

<sup>1</sup> For example, if an ITN campaign cost US\$ 5 million to deliver 2 million ITNs, then the unit-level cost (U) was \$2.50 per ITN (i.e. \$5 million divided by 2 million ITNs).

<sup>2</sup> For example, it can be estimated that the cost to deliver a single ITN includes the cost of the single ITN itself (e.g. \$1.25) plus a share of supply chain, delivery, implementation, etc. costs. These can be assigned by applying a percentage of the cost of the single ITN (e.g. 10% for supply chain, 20% for delivery, and 70% for implementation = 100% of the cost of an ITN). Therefore, in this example, the cost to delivery an ITN is \$1.25 + \$1.25 x (10%+20%+70%) = \$2.50 per ITN.

<sup>3</sup> As a simple example, the unit cost per person for a mass ITN campaign is the quotient of the cost of delivering a single ITN (e.g. \$2.50) and the number of persons presumed to be covered by a single ITN (e.g. 1.8). That is, \$2.50/1.8 = \$1.39 per person.

<sup>4</sup> For example, for Year 1 SMC in District 1, Pop should only include the eligible population (e.g. children age 3–59 months) for that year (e.g. population according to the last census x annual population growth) in that district.

AIDS, Tuberculosis and Malaria, bilateral donors) to help identify cost drivers and opportunities for improving efficiency.

With the total costs of the targeted combination of interventions calculated, that cost should be compared with the amount of funding expected to be available. The variance between the costs and the financial constraint should inform continued iteration of the combination of interventions. If budget is insufficient to fund the desired combination of interventions, further prioritization of intervention, targeting of operational units, or optimization of costs will be necessary.

The projected financial constraint should be estimated using the best available information, recognizing that future funding forecasts are often uncertain. Key inputs include:

- the total expected funding from all domestic and external sources for the costing period, excluding earmarked funds (e.g. funds allocated to vaccine distribution); and
- the portion of the funding envelope available, after setting aside amounts needed for essential but nonstratified activities (e.g. case management commodities, programme management, surveillance, digital systems).<sup>5</sup>

Once countries have developed their NMSP and operational plans, identifying the interventions, activities and subactivities to be implemented, detailed, activity-based micro costing can begin (1). Activity-based micro costing involves a stepwise approach to estimate the financial resources required for effective delivery.

**Table A.8.4. Key steps for activity-based costing**

Step	Description
<b>1. Specify resources for each subactivity</b>	For each intervention subactivity (e.g. training, logistics), identify the resources needed such as personnel, transport, supplies or equipment.
<b>2. Assign unit costs and quantify inputs</b>	Determine unit costs for each resource (e.g. cost per day, per item) and quantify inputs based on population needs, delivery modality or geographical coverage.
<b>3. Calculate and aggregate costs</b>	Multiply unit costs by quantities to estimate total resource costs. Aggregate these to obtain costs at subactivity, activity and full intervention levels. Table A8.5 is an example excerpt of a completed activity-based costing.
<b>4. Review and validate with stakeholders</b>	Share draft cost estimates with programme and subnational teams to validate assumptions, adjust for operational realities, and ensure local feasibility.

<sup>5</sup> The “reserve budget” can be challenging to estimate. Often it is advisable to use historical precedent to estimate an appropriate amount (e.g. previous budgets or expenditure).

**Table A8.5.** Example excerpt of completed activity-based costing

	<b>Intervention or cost item</b>	<b>Unit cost</b>	<b>Unit type</b>	<b>Quantity needed per year</b>	<b>Year 1 frequency</b>	<b>Year 2 frequency</b>	<b>Year 1 subtotal cost</b>	<b>Year 2 subtotal cost</b>	<b>Years 1–2 total cost</b>
<b>Intervention 1</b>	Mass distribution of ITNs						12 600	24 100	36 700
<b>Activity 1.1</b>	Training of campaign workers						600	100	700
<b>Subactivity 1.1.1</b>	Training materials development						600	0	600
<b>Resource 1.1.1.1</b>	Consultant fees	20.00	Per person per day	20	1	0	400	0	400
<b>Resource 1.1.1.2</b>	Airfare	100.00	Per roundtrip	2	1	0	200	0	200
<b>Subactivity 1.1.2</b>	Training materials dissemination						0	100	100
<b>Resource 1.1.2.1</b>	Printing	0.02	Per page	5 000	0	1	0	100	100
<b>Activity 1.2</b>	Supportive supervisions						12 000	24 000	36 000
<b>Subactivity 1.2.1</b>	Province to district supervision						12 000	24 000	36 000
<b>Resource 1.2.1.1</b>	Per diem	15.00	Per person per day	700	1	2	10 500	21 000	31 500
<b>Resource 1.2.1.2</b>	Vehicle hire	30.00	Per vehicle per day	50	1	2	1 500	3 000	4 500

## A8.4 Dealing with uncertainty

Costing exercises inherently involve uncertainty. This stems from variability in data quality, assumptions about implementation and differences across geographies. Acknowledging and transparently presenting this uncertainty helps decision-makers interpret results more appropriately.

Types of uncertainty commonly encountered in costing include:

- unit cost uncertainty – prices of inputs such as commodities, fuel or logistic services may vary over time or between procurement agents;
- quantification uncertainty – assumptions about quantities required (e.g. how many training sessions, supervision visits buffer stocks) may not always align with actual implementation needs;

- coverage and uptake uncertainty – the proportion of the target population that will be reached or comply with an intervention may vary, particularly in hard-to-reach areas; and
- exchange rate and inflation fluctuations – these can significantly affect costs in countries that rely on imported goods or external financing.

Ways to manage and communicate uncertainty include:

- cost ranges or confidence intervals – for any key cost assumption (whether a unit cost or quantity) with known variability, present a low and high estimate alongside the base case;
- scenario or sensitivity analysis – where feasible, analyse how total costs would change under alternative assumptions (e.g. fuel prices +10%, ITN wastage 5% versus 10%) to help identify which cost drivers are most sensitive and where better data are needed;
- transparent documentation – clearly list assumptions, data sources and where estimates are based on judgement or extrapolation rather than empirical data; and
- use of past expenditure or subnational variation – when possible, triangulate with previous expenditure data or compare costs across regions to highlight likely cost variation and improve realism.

Cost estimates often vary significantly across and within countries due to differences in geography, procurement systems, workforce compensation and delivery models. These factors can affect the transferability of cost data and should be clearly documented when adapting or interpreting estimates in different contexts. To support interpretation, costing outputs should clarify whether costs reflect national averages, urban versus rural contexts, or specific subnational implementation plans.

## References<sup>1</sup>

1. User guide for the malaria strategic and operational plan costing tool. Brazzaville: World Health Organization Regional Office for Africa; 2019 (<https://iris.who.int/handle/10665/325014>).

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<sup>1</sup> All references were accessed on 11 June 2025.

# Annex 9. Cost-effectiveness for decision-making

As part of the SNT process, countries must often determine which interventions and/or combinations of interventions are impactful, feasible and affordable. This annex chapter introduces how health economic evaluation can support key decisions, such as what intervention combinations to select, how to prioritize these combinations or how to optimize resources given a budget envelope.

Economic evaluation (EE) compares the relative costs and outcomes (or effects) of different courses of action (1) offering a systematic approach to compare the relative value of different options by assessing the health benefits achieved for the resources invested. Recognized by WHO as a key tool for value-for-money assessment, EE enables evidence-based decision-making by comparing the costs and health benefits of interventions. When used alongside other criteria such as equity and feasibility, EE helps strengthen the overall SNT process and supports more transparent, data-driven decision-making. Several types and approaches of EE are used to compare the costs and health outcomes of public health interventions, including cost-effectiveness analysis (CEA) and cost-utility analysis (CUA), as well as variations such as generalized CEA (GCEA), which differ in how outcomes are measured and what they are compared against:

- CEA typically express health outcomes in natural units such as cases averted, or deaths prevented. A variant of CEA where health outcomes are measured in standardized units such as quality-adjusted life years (QALYs) gained or DALYs averted is called cost-utility analysis (CUA). Combine length and quality of life, with values ranging from 0 (death) to 1 (full health), while DALYs measure the total years of healthy life lost due to illness, disability or premature death using an inverse scale from 0 (full health) to 1 (death or full disability) (2). DALYs are widely used in LMIC settings because they rely on standard disability weights and are less data-intensive than QALYs, making them a common choice for CUA. These metrics allow decision-makers to compare interventions across diseases and populations. In some cases, particularly when comparing similar interventions within the same programme area, simpler outcome measures such as cases averted, deaths prevented or hospitalizations avoided may be more intuitive and easier to communicate to stakeholders. However, these metrics reflect only one dimension of health impact and may not capture the full burden of disease. They do not account for factors such as severity, duration of illness or long-term disability, and therefore provide a more limited basis for comparing the value of different interventions across different diseases.
- Traditional CEA compares a new intervention to the current standard of care, providing insight into the additional cost and effect of introducing that specific intervention. Generalized CEA (GCEA) compares all interventions, including the current standard of care, to a common baseline or “null” scenario (i.e. if there were no intervention). GCEA enables broader comparisons across programmes even if they were introduced at different times and is particularly useful for long-term health system planning and strategic priority-setting at national or subnational levels.

The most common metric used in EE is the incremental cost-effectiveness ratio (ICER), which compares the additional cost and health outcomes of an intervention (or combination of interventions) relative to a baseline (such as the current standard of care or current combination of interventions or no intervention).<sup>1</sup> When the comparison is made to a “null” scenario, the calculation represents the average cost per unit of health gain and is referred to as the average cost-effectiveness ratio (ACER). After excluding dominated interventions, i.e., interventions that are both more costly and less effective than alternatives, selecting the intervention or combination of interventions with the lowest ICER or ACER provides the best value in terms of cost relative to its effectiveness.<sup>2</sup>

### ICER Formula:

$$\text{ICER} = \frac{\text{Cost}_A - \text{Cost}_{\text{baseline}}}{\text{Effect}_A - \text{Effect}_{\text{baseline}}}$$

Where:

- Cost<sub>A</sub> = cost of intervention or intervention combination A
- Cost<sub>baseline</sub> = cost at baseline
- Effect<sub>A</sub> = effectiveness of intervention or intervention combination A
- Effect<sub>baseline</sub> = effectiveness at baseline

To determine whether interventions offer good value, the ICER/ACER is compared to a cost-effectiveness threshold (CET). Historically, thresholds of 1–3 times gross domestic product (GDP) per capita per disability-adjusted life year (DALY) averted were widely used. However, WHO no longer endorses this approach, as these thresholds often overestimate the value of interventions and can lead to inefficient allocation of limited health resources. Instead, countries are encouraged to develop context-specific thresholds based on opportunity cost to better reflect their health system’s resource constraints and maximize health gains (4–6).

For further guidance, WHO provides tools and support to help countries use economic evaluation in decision-making. The WHO-CHOICE programme provides cost-effectiveness data, methodological guidance and tools to inform country-level analyses (7, 9).

<sup>1</sup> While ICER is the most commonly used metric in EE, other related metrics such as the incremental cost-utility ratio (ICUR) may be used when outcomes are measured in utility-based units, like quality-adjusted life years (QALYs). This approach is known as cost-utility analysis (CUA) that allows comparison of health interventions across different diseases and conditions by capturing both length and quality of life in a single measure. In contrast, traditional CEA typically uses disease-specific outcomes (e.g. cases or deaths averted) and is often more appropriate when comparing interventions within a single disease area.

<sup>2</sup> For additional guidance on how to compare health interventions using economic evaluation methods such as cost effectiveness, refer to (3).

## A9.1 Using GCEA within SNT

This section outlines how GCEA can support decision-makers in comparing combinations of interventions. In GCEA, when the comparator is the baseline or "null" scenario with zero cost and zero effect, and when the baseline or null has 0 cost and 0 effectiveness, the ICER is in this case is equivalent to the average cost-effectiveness ratio (ACER), which represents the average cost per DALY averted.

### A9.1.1 Comparing and selecting combinations of interventions

**Scenario:** An NMP is deciding between introducing two new combinations of interventions. The available information is presented in Table A9.1.

**Table A9.1. Information for GCEA for two new intervention combinations**

Intervention combination	Cost per person (US\$)	Cases averted per 1,000	Cost per case averted (US\$)
Combination A	3	2	1 500
Combination B	6	4	1 500
Combination A (remote districts)	8	2	4 000
Combination B (remote districts)	10	4	2 500
Baseline (comparator)	0	0	0

US\$: United States of America dollars.

**Approach: Compare each intervention to the baseline (comparator), calculate ACER:**

- ACER for Combination A:  $(3-0) / (0.002-0) = 1500$
- ACER for Combination B:  $(6-0) / (0.004-0) = 1500$
- ACER for Combination A (remote districts) =  $(8-0) / (0.002) = 4000$
- ACER for Combination B (remote districts) =  $(10-0) / (0.004-0) = 2500$

**Interpretation:** Under standard conditions, Combinations A and B are equally cost-effective (US\$ 1500 per case averted). In remote districts, delivery costs increase for both packages, reducing cost-effectiveness. However, Combination B remains more cost-effective than Combination A in remote districts (US\$ 2500 versus US\$ 4000 per case averted). If both packages are feasible to implement, Combination B may be preferred in remote districts based on relative cost-effectiveness, despite higher absolute costs (it averts twice as many cases, which lowers the cost per case averted. Whether it represents good value will also depend on the applicable cost-effectiveness threshold).

### A9.1.2 Selecting combinations under resource limitations

As part of assessing whether a combination of interventions is cost-effective, CEA supports decisions on how to allocate a fixed health budget. Interventions can be prioritized based on their ICERs, and resources allocated to those that provide the greatest health benefit per dollar spent. This involves comparing the costs and health

outcomes of various intervention combinations and selecting those with the lowest ACERs/ICERs until the budget is exhausted.

**Scenario:** An NMP has a fixed budget of US\$ 1200 to allocate across districts with a combined population of 100 individuals. It is considering two intervention combinations (Combination C and Combination D). If both were implemented fully for the entire population, the total cost would be US\$ 1500, exceeding the available budget. The programme must therefore prioritize based on cost per additional case averted (interventions with lower ACERs are considered more cost-effective). For simplicity, this example assumes that the two combinations are distinct, they target non-overlapping populations and have additive effects on cases averted. In real-world situations, overlapping effects between interventions (e.g. when both combinations include insecticide-treated nets or target the same population) may lead to diminishing returns. This example is illustrative and does not account for such interactions.

**Table A9.2. Information for prioritization using ACER**

Intervention combination	Cost per person (US\$)	Cases averted per 1,000	Cost per case averted (US\$)
Combination C	10	6.67	1 500
Combination D	5	2	2 500

US\$: United States of America dollars.

### Approach:

**Step 1:** Prioritize by cost-effectiveness. Combination C has a lower cost per case averted and is therefore more cost-effective than Combination D.

**Step 2:** Allocate funds (fixed budget of US\$ 1200). Combination C is fully funded at US\$ 1000 for 100 individuals and yields 0.667 cases averted. The remaining budget is US\$ 200.

**Step 3:** Consider the remaining budget. Combination D costs US\$ 5 per person (US\$ 500 for 100 people). With US\$ 200 remaining, the programme can cover 40 people with Combination D, and 0.08 ( $40 \times 0.002$ ) cases are averted.

**Interpretation:** By using ACERs to guide allocation, the programme achieves 0.747 ( $0.667 + 0.08$ ) cases averted within a US\$ 1200 budget, maximizing health impact.

Combination C is prioritized for its greater cost-effectiveness, while remaining funds are used for partial implementation of Combination D. A total of 140 individuals are covered with US\$ 1200.

In practice, resource allocation decisions should also account for programmatic feasibility, delivery constraints and equity considerations, not only cost-effectiveness considerations. For example, countries may set minimum coverage thresholds for underserved areas to ensure a baseline level of access, even if the interventions in those areas are less cost-effective, thereby balancing efficiency with equity goals. They may also consider factors such as past allocations, transmission risk and population composition. Therefore, EE ultimately complements, rather than drives, how resources are allocated across regions.

## A9.2 Data, methodological requirements and interpretations

While EE are typically conducted by technical experts, NMPs benefit from understanding the key inputs, assumptions and limitations that underpin these analyses. In addition to EE concepts and metrics presented in earlier sections, this section provides a quick-reference guide to help NMPs assess the quality and usefulness of EE and interpret ACERs/ICERs in context.

**Table A9.3. Key inputs and assumptions in EE**

Component	What it means	Why it matters
<b>Unit costs</b> (refer to <a href="#">annex 8</a> for more guidance on costing and costing data)	Cost per intervention or intervention combination (this should include all costs required to deliver the intervention, such as procurement, distribution, training, infrastructure, supervision, and overheads.)	Costs may differ significantly by area (e.g. IRS in remote versus urban settings), delivery channel, scale of implementation, seasonality, and local wage and price levels.
<b>Efficacy versus effectiveness<sup>a</sup></b>	Efficacy is from trials (ideal conditions); effectiveness is under real-world (routine programme) conditions	Real world factors (e.g. coverage, supply chain issues, health worker performance and adherence) are often lower than trial assumptions
<b>Comparator</b>	What the intervention or intervention combination is compared to (e.g. standard care, no intervention)	The comparator or baseline determines the ICER results, affecting how cost-effective interventions or a combination of interventions appear; different comparators can lead to very different cost-effectiveness estimates.
<b>Population subgroups</b>	Subgroups may be determined by age, gender, socio-economic status, transmission setting, risk level for example.	Cost-effectiveness may vary across populations (e.g. ITNs might be highly cost-effective in high-burden districts but not in areas with low transmission and strong case management)
<b>Time horizon</b>	Period over which costs and benefits are counted	Some benefits (e.g. reduced transmission) accrue or decline over years
<b>Discounting</b>	Adjusts future costs and benefits to present-day value (commonly 3–5% per year)	Affects comparisons between short-term and long-term interventions (higher discount rates reduce the present value of long-term benefits).
<b>Sensitivity analysis</b>	Tests how ICER results change when inputs vary	Helps identify key drivers of uncertainty and test the robustness of the results

ICER: incremental cost-effectiveness ratio; IRS: indoor residual spraying; ITN: insecticide-treated net.

<sup>a</sup> Efficacy trials (explanatory trials) determine whether an intervention produces the expected result under ideal circumstances. Effectiveness trials (pragmatic trials) measure the degree of beneficial effect under “real-world” clinical settings (10).

There are several technical considerations when reviewing the quality of an EE, including:

- Ask if local data were used – EE rely on many types of inputs, including unit costs, intervention coverage, disease burden, health system capacity and population characteristics. Using national or subnational data where possible improves relevance; global or regional averages may not reflect local realities and could lead to misleading conclusions.
- Check for sensitivity analysis – good EE explore how results change when key inputs vary (e.g. costs, coverage, efficacy), but they should also highlight uncertainty. This includes presenting ranges or confidence intervals around ICERs and using scenario or probabilistic analyses to show how robust the findings are under different real-world conditions.

Be cautious with thresholds – there is no one-size-fits-all CET, and countries are encouraged to use context-specific values based on opportunity cost.

Several key considerations should be considered when interpreting EE results in priority-setting, including :

- Do not rely on ICERs alone – a lower ICER suggests better value for money, but feasibility, population needs and political commitments also matter.
- Look at who benefits – EE should assess not only overall efficiency but also equity. Interventions targeting remote, marginalized, or high-risk groups may appear less cost-effective but are essential for fairness and health equity. Consider whether subgroup analyses were done (e.g. by geography, age or gender), and whether the distribution of costs (including out-of-pocket expenses) was examined, especially for vulnerable populations.
- Use EE to support, not replace, priority-setting decisions – it can help optimize impact, but decisions must also reflect broader programme goals.

## A9.3 Conclusion

EE are powerful tools that enhances the SNT process by helping NMPs identify which intervention combinations offer the best value for money in a given context. It supports rational, transparent and efficient use of resources, especially when trade-offs are inevitable. However, its utility depends on the quality of underlying data and assumptions, and it should always be interpreted alongside other considerations such as equity, feasibility and strategic goals. Used appropriately, EE strengthens, but does not replace, national and subnational decision-making.

## References<sup>2</sup>

1. Kee J. Cost–benefit analysis. In: Kempf-Leonard K, editor. Encyclopedia of social measurement. Amsterdam: Elsevier; 2005:537–44 (<https://doi.org/10.1016/B0-12-369398-5/00175-4>).
2. Weinstein MC, Torrance G, McGuire A. QALYs: the basics. Value Health. 2009;12(1):S5–S9. (<https://doi:10.1111/j.1524-4733.2009.00515.x>).
3. Drummond, MF., Sculpher, MJ, Torrance, GW, O'Brien, BJ, & Stoddart, GL. Methods for the economic evaluation of health care programme. Third edition. Oxford: Oxford University Press; 2005.
4. Bertram MY, Lauer JA, Stenberg K, Tan Torres Edejer T. Methods for the economic evaluation of health care interventions for priority setting in the health system: an update from WHO CHOICE. Int J Health Policy Manag. 2021;10(Special Issue on WHO-CHOICE Update):673–7 (<https://doi.org/10.34172/ijhpm.2020.244>).
5. Kazibwe J, Gheorghe A, Wilson D, Ruiz F, Chalkidou K, Chi Y-L. The use of cost-effectiveness thresholds for evaluating health interventions in low- and middle-income countries from 2015 to 2020: a review. Value Health. 2022;25(3):385–9 (<https://doi.org/10.1016/j.jval.2021.08.014>).
6. New cost-effectiveness updates from WHO-CHOICE [website]. World Health Organization; 2021 (<https://www.who.int/news-room/feature-stories/detail/new-cost-effectiveness-updates-from-who-choice>).
7. Economic evaluation & analysis [website]. World Health Organization; (<https://www.who.int/teams/health-financing-and-economics/economic-analysis>).
8. WHO-CHOICE: questions and answers [website]. World Health Organization; 2014 (<https://www.who.int/news-room/questions-and-answers/item/who-choice-frequently-asked-questions>).
9. World Health O. OneHealth Tool [website]. World Health Organization; (<https://www.who.int/tools/onehealth>).
10. Godwin M, Ruhland L, Casson I, MacDonald S, Delva D, Birtwhistle R et al. Pragmatic controlled clinical trials in primary care: the struggle between external and internal validity. BMC Med Res Methodol. 2003;3:28 (<https://doi.org/10.1186/1471-2288-3-28>).

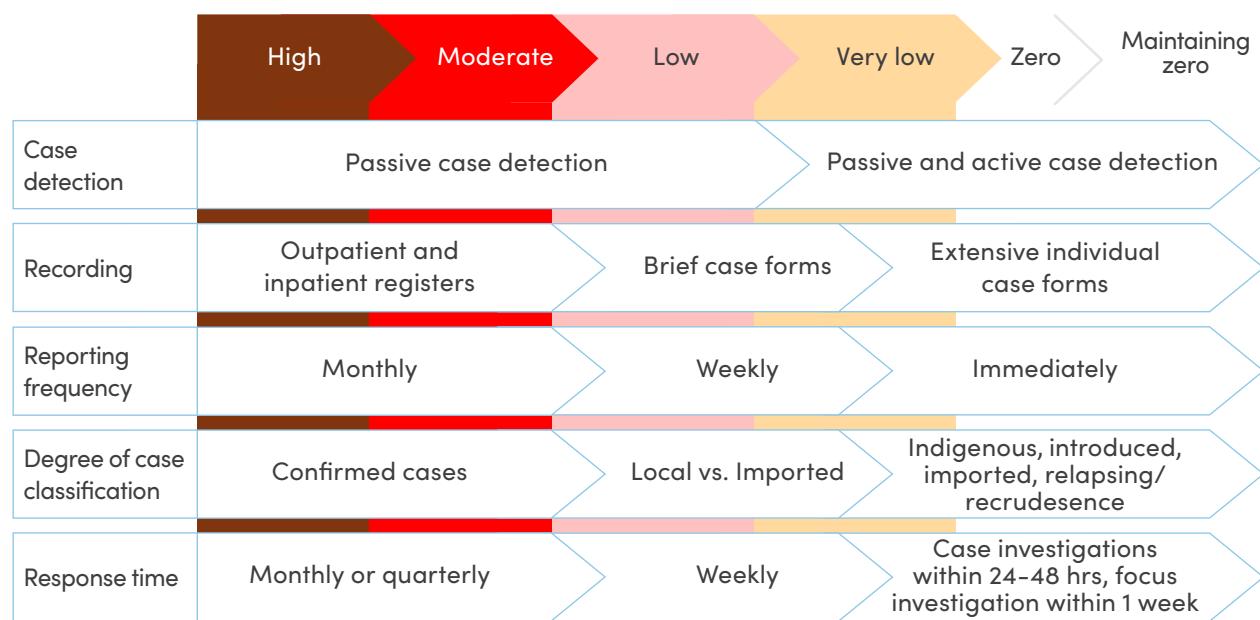
<sup>2</sup> All references were accessed on 11 June 2025.

# Annex 10. Surveillance, monitoring and evaluation

## A10.1 Malaria surveillance for different transmission settings

Surveillance systems are the foundation of strategic malaria control, enabling data-driven decisions through reliable data generation, analysis and application (1). They help identify at-risk populations, assess transmission levels, evaluate intervention impacts and set subnational targets. Surveillance guides resource allocation, improves delivery methods and supports responses to outbreaks and emergencies. A key feature is adaptability to varying transmission levels (Fig. A10.1), reflecting how surveillance needs shift across high to zero transmission settings. By supporting elimination certification, monitoring re-establishment of transmission, and ensuring accountability, surveillance systems are essential for sustained malaria progress.

**Fig. 10A.1. Key surveillance characteristics for different transmission settings**



Source: WHO (2).

Some of the main sources of strategic information are described below.

- **Routine health information systems** may cover multiple programmes, be specific to malaria or be limited to certain activities (e.g. laboratory services, interventions, distribution, surveillance).
- **Detailed epidemiological data from case-based malaria surveillance systems** may be implemented when case numbers are low enough to match the resources needed to undertake such intensive surveillance.
- **Health facility surveys** usually address whether facilities have the physical and human resources necessary to provide services (especially chemoprevention, diagnostic testing and treatment), and may include whether patients receive diagnostic testing and appropriate treatment.
- **National household surveys** usually cover several health interventions, may capture health-seeking behaviour, and often target children under 5 years of age and women of reproductive age. They are useful for point estimates. **Targeted household surveys** include smaller samples and are primarily useful for threshold management rather than point estimates. Malaria-specific surveys are also common.
- **Operational or implementation research** usually addresses specific questions of relevance to the malaria programme, may rely on household or health facility surveys, and may include studies of drug or insecticide efficacy.
- **Entomological surveillance** is used for understanding the distribution of the main malaria vectors, their behaviour and changes in their biting habits in response to the intervention. It is part of sentinel surveillance by national programmes and often includes vector resistance to insecticides.
- **Supervision of health services** provides data on central, intermediate, health facility and health worker levels.
- **Contextual data** are not collected routinely or during operational research but are useful for further understanding and explaining changing trends in the malaria burden. They include population censuses and climate and socioeconomic data.
- **Social science and qualitative research** investigates and provides data on treatment-seeking behaviour and barriers to access.
- **Climate data** from national metrological departments and online data portals provides information on rainfall and other metrics relevant to malaria epidemiology.

Based on the subnational context and national goals, various strategies can enhance the surveillance system to generate high-quality data for decision-making, such as strategic planning, targeting interventions, operational delivery, monitoring impact, and measuring progress in reducing disease burden. Strengthening efforts should focus on (Table A10.1):

- enhancing data quality and use and the representativeness of the surveillance system;
- ensuring context-appropriate digital health information systems to support surveillance processes;
- building human resource capacity for surveillance implementation and data use; and
- creating an enabling environment through guidelines, resources and governance.

**Table A10.1. Areas for consideration to strengthen surveillance, monitoring and evaluation capacity**

Category	Example actions to be adapted to local context
<b>Data quality, use and representativeness of the surveillance system</b>	<p>Update geolocated master lists of all facilities diagnosing and/or treating malaria in all health sectors</p> <p>Report all suspected and confirmed (parasitological diagnosis) cases</p> <p>Standardize malaria indicators using WHO-recommended standards</p> <p>Assess surveillance system gaps (using the WHO Malaria Surveillance Assessment Toolkit (3)), including data quality gaps, and address identified gaps</p> <p>Address data quality, data-flow bottlenecks and capacity gaps by simplifying tools, digitizing reporting processes and developing standard operating procedures</p> <p>Collect and analyse data (e.g. descriptive trend analysis, population at risk) regularly at all levels of the malaria programme</p> <p>Establish routine data review standard operating procedures and mechanisms at subnational levels for trend analysis and action planning (e.g. involvement of subnational teams in developing operational plans)</p> <p>Provide regular, unbiased feedback to all levels of the health system</p> <p>Use SNT of interventions for intervention prioritization and planning (e.g. for developing costed national strategic and operational plans)</p> <p>Monitor critical indicators through systematized monitoring and evaluation and ensure malaria interventions are effective, efficient and aligned with programme goals</p>
<b>Effective, sustainable and context-appropriate health information systems</b>	<p>Ensure health information systems evolve as malaria transmission decreases (e.g. reporting individual case data in addition to aggregate reports)</p> <p>Develop digital tools from a user perspective aligning with local needs</p> <p>Design locally informed, user-friendly dashboards (e.g. DHIS2 standard modules) with disaggregated data (by age and sex)</p> <p>Transition to scalable, low-cost digital systems with standardized surveillance packages, such as DHIS2, which can be tailored to local contexts</p> <p>Develop a National Malaria Data Repository (NMDR) which aligns and integrates malaria surveillance within broader HMISs</p>

Category	Example actions to be adapted to local context
<b>Human resource capacity</b>	<p>Advocate for gender-balanced staffing and training in data-collection and analysis roles</p>
	<p>Strengthen analytical capacity at all levels of the health system, including technical assistance for the start-to-end SNT process (including data assembly, cleaning, analysis and interpretation)</p>
	<p>Provide standardized training for health workers on use and maintenance of digital health systems and prevent system obsolescence</p>
	<p>Collaborate with academic and local and global institutions for local capacity-building (e.g. to strengthen SNT capacity)</p>
	<p>Establish communication channels between ministries, departments and stakeholders</p>
	<p>Identify champions to promote surveillance programme ownership at all levels</p>
<b>Enabling environment</b>	<p>Clearly define roles and responsibilities across stakeholders (e.g. terms of reference for epidemiologists working on SNT – see Annex 1)</p>
	<p>Formulate relevant national surveillance and data analysis guidelines and standard operating procedures that align with WHO technical strategies (e.g. for SNT analysis) but are adaptable to local contexts</p>
	<p>Formulate relevant surveillance plans (i.e. countries with areas prone to epidemics or transitioning from burden reduction to elimination should have an epidemic preparedness and response plan)</p>
	<p>Advocate for long-term financial commitments and sustainability to support surveillance activities and ensure system continuity</p>
	<p>Regularly evaluate and upgrade facilities, tools and systems to meet evolving needs</p>

HMIS: health management information system; SNT: subnational tailoring.

## A10.2 SNT monitoring and evaluation checklist

The monitoring and evaluation framework presented as a checklist in Table A10.2 has been developed to guide the systematic country-level assessment of the design, implementation and outcomes of the SNT approach. The framework aims to be flexible and adaptable, recognizing that countries will implement different steps of the SNT process based on their epidemiological context, programmatic priorities and available resources.

The framework is structured around seven key components, each with guiding questions, indicators, data sources and assumptions. Each component includes specific key questions and indicators, which serve as a standardized yet adaptable means of assessing the SNT process at the national and subnational levels.

The framework is designed to be adaptable, recognizing that countries may implement only selected SNT steps based on their context. It employs a packaged-methods approach for comprehensive assessment. Stakeholder engagement and continuous feedback loops ensure that outputs are actionable, fostering a learning-oriented approach that informs real-time decision-making and long-term strategic planning.

To enhance the effectiveness of the framework, NMPs should align monitoring and evaluation activities with existing surveillance systems, such as HMIS, and strengthen data analysis capacity at all levels.

**Table A10.2. Monitoring and evaluation framework checklist**

Component	Objective	Key questions	Indicators	Data source/methods	Assumptions
<b>1. Defining the starting point</b>	Determine the key malaria control questions to be addressed and assess the availability and quality of data for answering these questions.	What are the key malaria control questions to be addressed (e.g. where are additional vector control interventions required)?	List of initial malaria control questions	Stakeholder consultations, malaria reports	Stakeholders agree on initial questions
		What data is available to answer these questions?	Availability, type, and completeness of baseline data	HMIS, entomological reports, survey data, data quality reports (e.g. surveillance assessment findings), NMDR where relevant	Data is of sufficient quality
<b>2. Approach and methodology</b>	Document and assess the appropriateness of methodologies applied for answering malaria control questions, including stakeholder involvement and the integration of gender, equity, and diversity (GED) considerations.	What methods were used to answer key questions?	Methods documented and justified	Analysis reports, meeting minutes	Best-fit methodologies were applied
		Were data sources integrated effectively?	Number and type of sources used for triangulation	Review of stratification and intervention planning reports	Data integration capacity exists
		Was there any stakeholder consultation in selecting methods?	Number and expertise of stakeholder for methodology selection	Consultation meeting records, TORs, attendance lists	Methodological decisions are transparent and inclusive
		Were gender-sensitive and equity-focused methodologies used in data collection and analysis?	Number of methodologies incorporating GED considerations	Evaluation reports, data-collection tools	GED considerations are prioritized and feasible to apply

Component	Objective	Key questions	Indicators	Data source/methods	Assumptions
<b>3. Assumptions, and data gaps</b>	Document key assumptions, data limitations and implementation barriers that may affect decision-making and intervention effectiveness.	What key assumptions were made in decision-making?  What data or research gaps were identified?	Documented assumptions  List of identified gaps	Strategy notes, technical working group reports  Monitoring and evaluation reports, national surveillance gaps analysis	Stakeholders acknowledge uncertainty  Gaps are systematically recorded
<b>4. Implementation steps taken</b>	Track the extent to which SNT steps were applied, identify modifications made, and assess external factors that influenced implementation.	Which SNT steps were applied, and to what extent were these steps completed?  Who collaborated on the implementation of the different steps of SNT?  Were any modifications made to the SNT steps during implementation?	Number and type of SNT steps implemented  List of collaborators within and outside country  Documented modifications and justifications	Stakeholder consultations, malaria reports  Review of workplans and implementation tracking  Review of workplans and implementation tracking/checklists for knowledge management	Countries prioritize relevant SNT steps  Resources and technical support are adequate  Resources and technical support are adequate
		What external factors influenced the decision to implement specific steps?	Summary of external factors affecting decision-making	Stakeholder consultations	Resources and technical support are adequate
		What implementation (of SNT approach) challenges were faced and what were the key lessons for success?	Commonly reported implementation barriers and enablers (e.g. analytical capacity, costing data, governance, policy, partnerships)	Stakeholder feedback, supervision reports	Challenges and key enablers are openly discussed and addressed

Component	Objective	Key questions	Indicators	Data source/methods	Assumptions
<b>5. Key outputs and lessons learned</b>	Systematically record key outputs, emerging insights, and capacity gaps observed during implementation.	Were initial questions answered from the implementation of SNT?	Summary of key findings	Evaluation reports, country case studies	Findings are systematically captured and reported
		What lessons emerged from the implementation of SNT?	Summary of lessons learned	Stakeholder consultations	Lessons are systematically captured and reported
		Were lessons learned shared with internal and external partners, and acted upon?	Summary of partners that received feedback and actions taken to address the feedback	Dissemination plans	Feedback mechanisms are in place and functional
<b>6. Utilization of findings</b>	Assess how findings were used to refine malaria strategies, inform national malaria control programmes, and establish feedback mechanisms for continuous improvement.	Were findings used to inform or modify national malaria strategies, plans or programmatic outputs? If so, which ones, and how?	Documentation of policy or strategy modifications	Updated intervention plans, National malaria strategy updates	Countries are responsive to findings and stakeholders use evidence for decision-making
		Were specific recommendations made to improve equitable access to malaria services?	List of policy recommendations addressing gender and equity inequities	National malaria strategy updates	GED findings are reflected in strategy and implementation
<b>7. Impact assessment</b>	Evaluate whether interventions were more effectively targeted, whether cost efficiencies were achieved, and what broader health and programmatic impacts were realized, compared with business as usual.	Were cost efficiencies achieved?	Cost savings from optimization	Cost-effectiveness analyses, financial reports	Funding data is accurately tracked
		Were interventions more effectively targeted?	Improved intervention coverage in priority areas	Implementation tracking, coverage surveys	Stratification led to meaningful intervention targeting
		What broader impact was achieved?	Reduction in malaria burden	National malaria surveillance reports	External factors did not significantly alter intervention impact

GED: gender, equity and diversity; HMIS: health management information system; NMDR: national malaria data repository; SNT: subnational tailoring; TOR: terms of reference.

## References<sup>1</sup>

1. Malaria surveillance, monitoring and evaluation: a reference manual, second edition. Geneva: World Health Organization; 2025 (<https://iris.who.int/handle/10665/381864>).
2. Global technical strategy for malaria 2016–2030, 2021 update. Geneva: World Health Organization; 2021 (<https://iris.who.int/handle/10665/342995>).
3. Malaria Surveillance Assessment Toolkit [website]. World Health Organization; 2024 (<https://malsurtoolkit.who.int/>).

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<sup>1</sup> All references were accessed on 11 June 2025.



For further information please contact:

**World Health Organization**

20, avenue Appia  
CH-1211 Geneva 27  
[who.int/teams/global-malaria-programme](http://who.int/teams/global-malaria-programme)  
Email: GMPinfo@who.int