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Household Survey Indicators for Malaria Control

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Acronyms

ACT	Artemisinin-based Combination Therapies
ANC	Antenatal Care
CCM	Community Case Management
CHERG	Child Health Epidemiology Reference Group
DHS	Demographic and Health Survey
GMAP	Global Malaria Action Plan
Hb	Hemoglobin
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information Systems
IPTp	Intermittent Preventive Treatment in Pregnancy
IRS	Indoor Residual Spraying
ITN	Insecticide-Treated Net
LiST	Lives Saved Tool
LLIN	Long-Lasting Insecticidal Net
M&E	Monitoring and Evaluation
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Survey
MIS	Malaria Indicator Survey
NGO	Non-Governmental Organization
PMI	President's Malaria Initiative
RBM	Roll Back Malaria
RDT	Rapid Diagnostic Test
SP	Sulfadoxine-pyrimethamine
SSA	Sub-Saharan Africa
U5MR	Under-five Mortality Rate
UN	United Nations
UNICEF	United Nations Children's Fund
$_5q_0$	All-cause Under Five Mortality
WHO	World Health Organization

1. Introduction

1.1 Background

Malaria poses a tremendous public health problem across the globe with an estimated 3.3 billion, or 40 percent of the world's population, living in areas of malaria risk. Worldwide, an estimated 219 million malaria episodes and 660,000 malaria deaths occurred in 2010 [1]. While malaria is endemic within most tropical and subtropical regions of the world, over 90 percent of all malaria deaths currently occur in sub-Saharan Africa (SSA). Young children and pregnant women represent those at greatest risk of malaria-related morbidity and mortality, especially in areas of stable transmission. It has recently been estimated that malaria is responsible for approximately 15 percent of all deaths among children less than five years of age in SSA and that 86 percent of all deaths due to malaria are among children under five [2]. Malaria also places an enormous toll on already overburdened health systems across SSA and elsewhere.

The last 15 years have seen a resurgence of interest in malaria as a disease of major public health importance. To coordinate the efforts of the international community, the Roll Back Malaria (RBM) partnership was launched in 1998 with the vision of a world free of malaria. Its initial goal has been to halve the number of malaria cases and deaths by 2010, as described in the Global Malaria Action Plan (GMAP) [3]. Although this goal has not yet been met, significant strides in malaria control efforts have reduced malaria deaths in many countries. In the Africa Region, the estimated number of deaths per 100,000 population fell from 125 per 100,000 in 2000 to 84 per 100,000 in 2010. Eight countries in sub-Saharan Africa reported at least a 50 percent reduction in the number of confirmed malaria or malaria admissions and deaths between 2000 and 2010[1] and another four showed reductions of 25–50 percent. In all countries, the decreases are associated with intense malaria control interventions. In other regions, the number of reported cases of confirmed malaria decreased between 2000 and 2010 by more than 50 percent in 35 of the 53 malaria-endemic countries with ongoing transmission. Downward trends of 25-50 percent were seen in four other countries. In 2010, the European Region was on target to eliminate malaria, reporting only 176 indigenous cases [1].

In the light of progress made by 2010, RBM updated the GMAP goals, objectives and targets in June 2011 (Table 1). Maintaining an overall vision of a "malaria-free world" [4], the objectives are now to:

(i) reduce global malaria deaths to near zero by end-2015[2];
(ii) reduce global malaria cases by 75 percent from 2000 levels by end-2015; and
(iii) eliminate malaria by end-2015 in 10 new countries since 2008, including in the World Health Organization (WHO) European Region.

These targets will be met by achieving and sustaining universal access to and utilization of preventive measures including vector control; achieving universal access to diagnostic testing and treatment in the public and private sectors and in the community (including appropriate referral); and accelerating the development of surveillance systems [4].

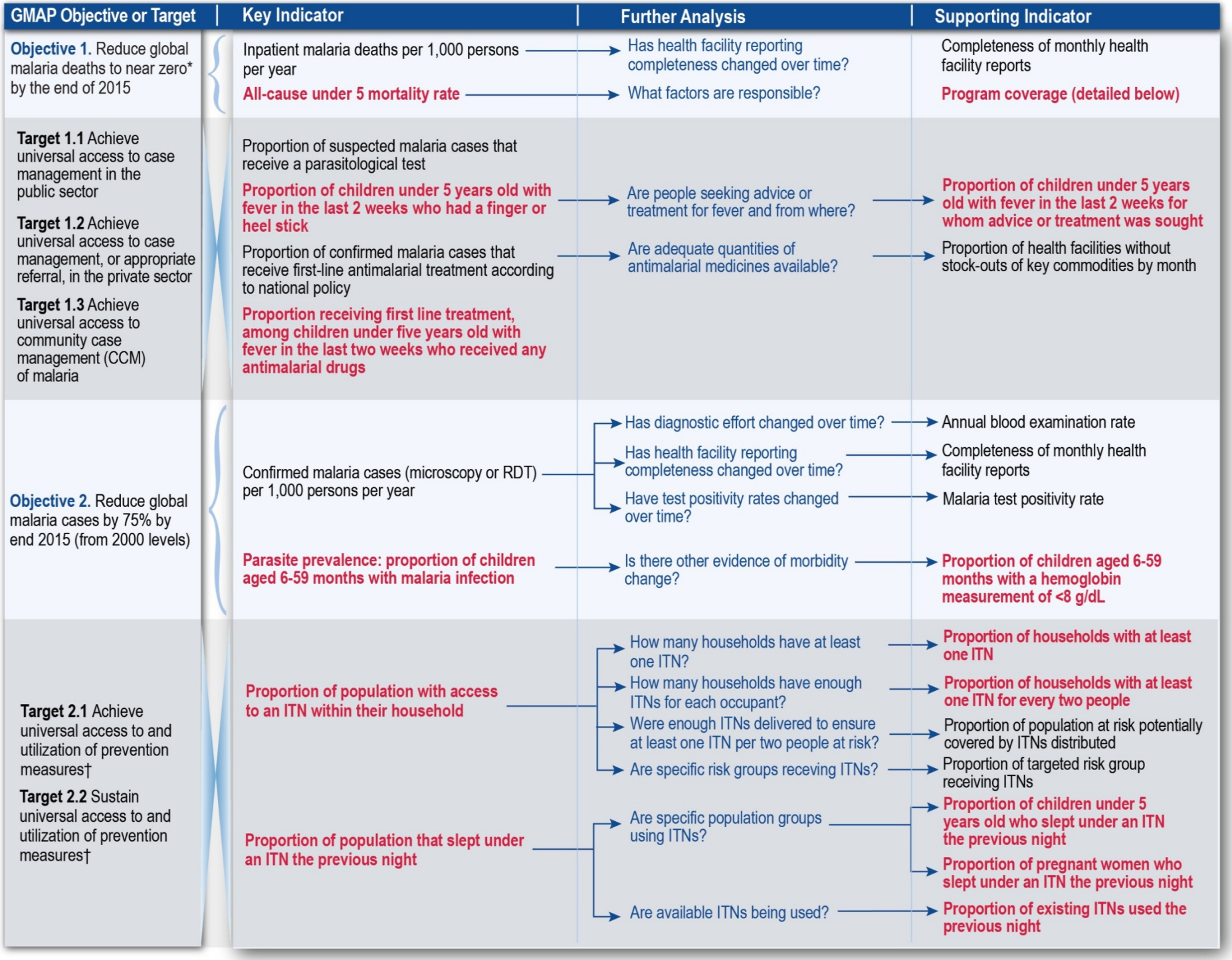
[1] Botswana, Cape Verde, Namibia, Rwanda, Sao Tome and Principe, South Africa, Swaziland, and United Republic of Tanzania (Zanzibar)
[2] This differs from the target set by the World Health Assembly to reduce deaths by 75% by 2015.

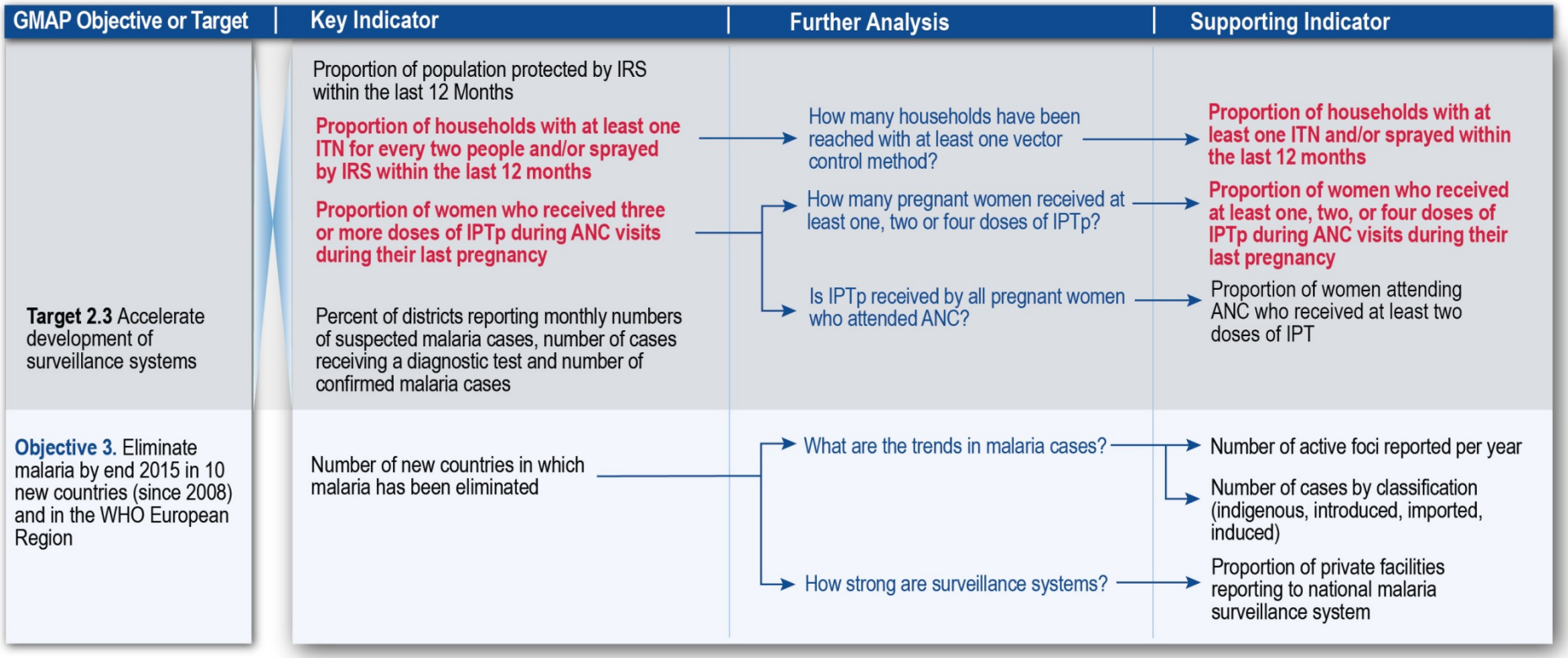
Table 1: **Updated GMAP Objectives, Targets, and Milestones Beyond 2011**

Vision: *Achieve a malaria-free world*		
Objective	**Targets**	**Milestones**
Objective 1 Reduce global malaria deaths to near zero by end-2015	**Target 1.1** Achieve universal access to case management in the public sector. By end 2013, 100% of suspected malaria cases receive a malaria diagnostic test and 100% of confirmed cases receive treatment with appropriate and effective antimalarial drugs.	None, as the target is set for 2013.
	Target 1.2 Achieve universal access to case management, or appropriate referral, in the private sector. By end 2015, 100% of suspected malaria cases receive a malaria diagnostic test and 100% of confirmed cases receive treatment with appropriate and effective antimalarial drugs.	By end 2013, in endemic countries, 50% of persons seeking treatment for malaria-like symptoms in the private sector report having received a malaria diagnostic test and 100% of confirmed cases having received treatment with appropriate and effective antimalarial drugs.
	Target 1.3 Achieve universal access to community case management (CCM) of malaria. By end 2015, in countries where CCM of malaria is an appropriate strategy, 100% of fever (suspected) cases receive a malaria diagnostic test and 100% of confirmed uncomplicated cases receive treatment with appropriate and effective antimalarial drugs, and 100% of suspected and confirmed severe cases receive appropriate referral.	1. By end 2012, all countries where CCM of malaria is an appropriate strategy have adopted policies to support CCM of malaria (including use of diagnostic testing and effective treatment). 2. By end 2013, in all countries where CCM of malaria is an appropriate strategy, 80% of fever cases receive a malaria diagnostic test and 80% of confirmed cases receive treatment with effective antimalarial drugs.

Objective 2 Reduce global malaria cases by 75% by end 2015 (from 2000 levels)	**Target 2.1** Achieve universal access to and utilization of prevention measures. By end 2013, in countries where universal access and utilization have not yet been achieved, achieve 100% access to and utilization of prevention measures for all populations at risk with locally appropriate interventions.	None, as the target is set for 2013.
	Target 2.2 Sustain universal access to and utilization of prevention measures. By 2015 and beyond, all countries sustain universal access to and utilization of an appropriate package of preventive interventions.	From 2013 through 2015, universal access to and utilization of appropriate preventive interventions are maintained in all countries.
	Target 2.3 Accelerate development of surveillance systems. By end 2015, all districts are capable of reporting monthly numbers of suspected malaria cases, number of cases receiving a diagnostic test and number of confirmed malaria cases from all public health facilities, or a consistent sample of them.	By end 2013, 50% of malaria endemic countries have met the 2015 target.
Objective 3 Eliminate malaria by end 2015 in 10 new countries (since 2008) and in the WHO European Region		By end 2013, malaria is eliminated in 3 new countries.

The updated targets not only provide direction for the design of malaria control programs but also provide a framework for monitoring and evaluation; in particular, they influence the choice of the indicators that should be used to monitor progress. A list of recommended indicators against each target is shown in Table 2. Indicators that can be generated from household surveys are shown in **red**. In some cases, the indicators generated by household surveys do not measure a target directly, such as parasite prevalence, but the indicator is in widespread use so it has been placed by the most appropriate target.


GMAP Objective or Target
Key Indicator
Further Analysis
Supporting Indicator
Objective 1. Reduce global malaria deaths to near zero* by the end of 2015
Inpatient malaria deaths per 1,000 persons per year
Has health facility reporting completeness changed over time?
Completeness of monthly health facility reports
All-cause under 5 mortality rate
What factors are responsible?
Program coverage (detailed below)
Target 1.1 Achieve universal access to case management in the public sector
Target 1.2 Achieve universal access to case management, or appropriate referral, in the private sector
Target 1.3 Achieve universal access to community case management (CCM) of malaria
Proportion of suspected malaria cases that receive a parasitological test
Proportion of children under 5 years old with fever in the last 2 weeks who had a finger or heel stick
Are people seeking advice or treatment for fever and from where?
Proportion of children under 5 years old with fever in the last 2 weeks for whom advice or treatment was sought
Proportion of confirmed malaria cases that receive first-line antimalarial treatment according to national policy
Are adequate quantities of antimalarial medicines available?
Proportion of health facilities without stock-outs of key commodities by month
Proportion receiving first line treatment, among children under five years old with fever in the last two weeks who received any antimalarial drugs
Objective 2. Reduce global malaria cases by 75% by end 2015 (from 2000 levels)
Confirmed malaria cases (microscopy or RDT) per 1,000 persons per year
Has diagnostic effort changed over time?
Annual blood examination rate
Has health facility reporting completeness changed over time?
Completeness of monthly health facility reports
Have test positivity rates changed over time?
Malaria test positivity rate
Parasite prevalence: proportion of children aged 6-59 months with malaria infection
Is there other evidence of morbidity change?
Proportion of children aged 6-59 months with a hemoglobin measurement of <8 g/dL
Target 2.1 Achieve universal access to and utilization of prevention measures†
Target 2.2 Sustain universal access to and utilization of prevention measures†
Proportion of population with access to an ITN within their household
How many households have at least one ITN?
Proportion of households with at least one ITN
How many households have enough ITNs for each occupant?
Proportion of households with at least one ITN for every two people
Were enough ITNs delivered to ensure at least one ITN per two people at risk?
Proportion of population at risk potentially covered by ITNs distributed
Are specific risk groups receving ITNs?
Proportion of targeted risk group receiving ITNs
Proportion of population that slept under an ITN the previous night
Are specific population groups using ITNs?
Proportion of children under 5 years old who slept under an ITN the previous night
Proportion of pregnant women who slept under an ITN the previous night
Are available ITNs being used?
Proportion of existing ITNs used the previous night



▮ Indicator derived from household surveys

* In areas where public health facilities are able to provide a parasitological test for all suspected malaria cases, near zero malaria deaths is defined as no more than 1 confirmed malaria death per 100,000 population at risk.

† Universal access to and utilization is defined as every person at risk sleeping under a quality insecticide-treated net or in a space protected by indoor residual spraying and every pregnant woman at risk receiving at least one dose of intermittent preventive treatment (IPTp) during each of the second and third trimesters (in settings where IPTp is appropriate).

Household surveys are suitable for measuring progress towards some, but not all, of the targets. In other cases, reliance must be placed on routine health information systems as the primary source of data, particularly for tracking trends in cases. Accordingly, the updated GMAP targets have a specific target (2.3) for development of surveillance systems. Where data from routine health information systems are used, their interpretation may benefit from the insight provided by household surveys. For example, they may help to ascertain the percentage of patients with a febrile illness that attend public sector health facilities and thus provide information on the coverage of surveillance systems. Therefore, household surveys and routine health information systems should be seen as complementary and not competing.

Household surveys generate 13 outcome indicators and 3 impact indicators that can be used to measure progress towards GMAP targets (Table 3). Some interventions, such as intermittent preventive treatment in pregnancy (IPTp) and indoor residual spraying (IRS), may not be implemented in all countries, so certain indicators may not be used in all settings.

Table 3: Household Survey Indicators for Assessing Progress towards GMAP Targets

Intervention	Indicator Description
Prevention	
Vector Control via Insecticide-Treated Nets (ITN) and Indoor Residual Spraying (IRS)	1. Proportion of households with at least one ITN
	2. Proportion of households with at least one ITN for every two people **(NEW)**
	3. Proportion of population with access to an ITN within their household **(NEW)**
	4. Proportion of population that slept under an ITN the previous night
	5. Proportion of children under five years old who slept under an ITN the previous night
	6. Proportion of pregnant women who slept under an ITN the previous night
	7. Proportion of existing ITNs used the previous night **(NEW)**
	8. *Households covered by vector control*: Proportion of households with at least one ITN and/or sprayed by IRS in the last 12 months
	9. *Universal coverage of vector control*: Proportion of households with at least one ITN for every two people and/or sprayed by IRS within the last 12 months **(NEW)**
Intermittent Preventive Treatment during Pregnancy (IPTp)	10. Proportion of women who received three or more doses of IPTp for malaria during ANC visits during their last pregnancy **(UPDATED)**
Case Management	
Diagnosis	11. Proportion of children under five years old with fever in the last two weeks who had a finger or heel stick
Treatment	12. Proportion of children under five years old with fever in the last two weeks for whom advice or treatment was sought **(NEW)**
	13. Proportion receiving an Artemisinin-based Combination Therapy (ACT) (or other appropriate treatment), among children under five years old with fever in the last two weeks who received any antimalarial drugs **(NEW)**
Impact Measure	**Indicator Description**
Morbidity Indicators	14. Parasite Prevalence: proportion of children aged 6-59 months with malaria infection
	15. Anemia Prevalence: proportion of children aged 6-59 months with a hemoglobin measurement of <8 g/dL
Mortality Indicator	16. All-cause under five mortality rate (U5MR)

1.2 Purpose and Content of Manual

The purpose of this manual is to provide detailed specifications for the indicators that can be measured through household surveys and the data that is required for their construction, as well as the issues related to their interpretation. Details of the data collection methods required for estimating these indicators through national-level household surveys are also provided. This manual is intended to maximize internal consistency and comparability of the indicators and the types of data collection methods used across countries and over time.

It should be noted that the indicators and measurement tools described in this guide were developed in the context of the high malaria burden countries of Africa. While children under five and pregnant women are most at risk for malaria in these settings, programs are attempting to attain universal coverage and utilization of vector control interventions across all age groups. Monitoring and evaluation efforts will reflect this program emphasis. In other settings, such as Southeast Asia and Latin America, where the distribution of malaria is more focal, a more targeted approach to monitoring and evaluation may be necessary and large, nationally representative surveys to measure coverage may be less useful or may be conducted less frequently. Likewise, the indicators to measure ITN use or IPTp may not reflect the preventive strategies used in some settings. This guide focuses on indicators for monitoring progress in Africa and other high transmission settings because of the critical need to track the scale up of key interventions and provide evidence of their impact in areas with the highest disease burden and greatest investment in malaria control.

Due to increased funding in the past few years, malaria control efforts have expanded rapidly, and interventions have evolved with the changing funding climate. Technical strategies for the control and prevention of malaria have also evolved according to new evidence from the field and changes in technical recommendations and strategic targets. For example, WHO recommended in 2009 that all suspected cases of malaria should receive a diagnostic test [5] and, in 2012, updated its recommendation regarding IPTp [6]. Given these changes, this manual has been reviewed and revised substantially from the version published in 2009. The principal changes are summarized in Table 4.

This manual begins with a brief discussion of the basic principles of monitoring and evaluation. It then discusses the different types of household surveys commonly used in monitoring and evaluation of malaria programs. Issues related to measurement, as well as interpretation of indicators from household surveys, are then discussed. The manual concludes with detailed guidelines for constructing each indicator; outcome indicators are organized by intervention and are followed by impact indicators. A brief explanation of each intervention is provided. Indicators that are no longer recommended for use are presented in Section 3.3 (33), as well as in Annex 1.

Table 4: Changes to the Indicators in the 2012 Indicators Manual

New and Updated Indicators

Prevention
▪ A new indicator which assesses the proportion of households with at least one ITN for every two people. (Page 19) ▪ A new indicator of access to ITNs which provides a measure of the proportion of the population that has access to an ITN in their household. (Page 20) ▪ A new indicator of ITN utilization which examines the extent to which ITNs existing in households are used. (Page 25) ▪ A new indicator which provides a measure of universal coverage of vector control. (Page 27) ▪ An updated indicator that measures the proportion of pregnant women who receive three or more doses of intermittent preventive treatment in pregnancy during ANC visits, reflecting updated WHO policy. (page 31)
Case Management
▪ A new indicator of access to care which describes the proportion of children under five years old with fever in the last two weeks for whom advice or treatment was sought. (Page 36) ▪ A new indicator for measuring the proportion of children under five years old with fever that received any ACT or other first-line antimalarial treatment (i.e., according to national guidelines) among those taking any antimalarial. (Page 37)

Indicators No Longer Recommended

Case Management
▪ Proportion of children under five years old with fever in last 2 weeks who received antimalarial treatment according to national policy within 24 hours from onset of fever ▪ Proportion of children under five years old with fever in the last two weeks who received any antimalarial treatment

2. Monitoring and Evaluation

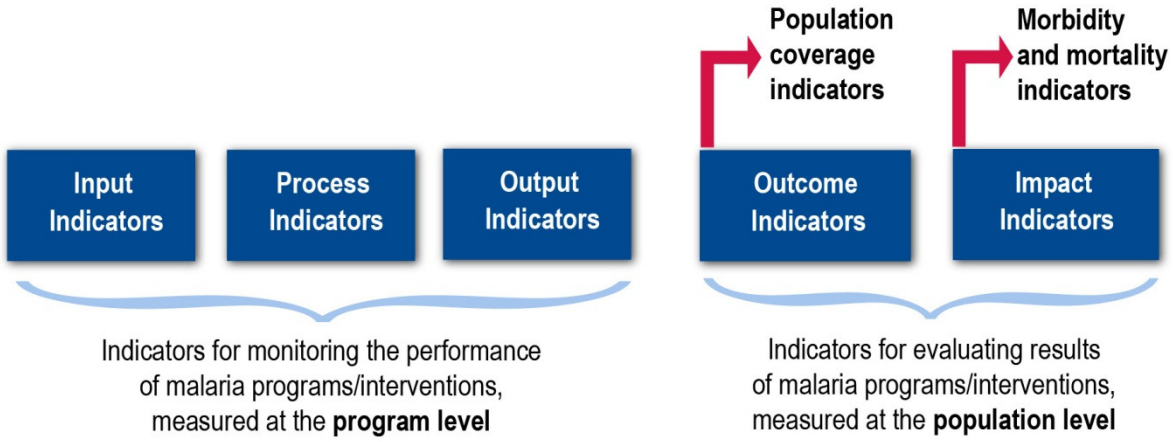
2.1 Principles of Monitoring and Evaluation

Monitoring is a continuous process of gathering and using data on program implementation with the aim of ensuring programs are proceeding satisfactorily or making adjustments, if necessary. It often uses administrative data and tracks inputs, processes and outputs, although it can also consider program outcomes and impacts.

Evaluation is a more comprehensive assessment of a program, which is normally undertaken at discrete points in time and focuses on the longer term outcomes and impacts of programs. The overall goal of M&E is to improve program efficiency, effectiveness and equity. M&E may be focused on local initiatives as well as measuring program effectiveness at the national and regional levels. Ideally, M&E tools can be used to demonstrate to planners and other decision-makers that program efforts have had measurable impacts on the outcomes of interest. M&E can also provide insight as to where resources are being used most efficiently versus where new strategies should be considered.

Monitoring is used to verify, step-by-step, the progress of malaria control programs at various levels to see whether activities are implemented as planned. Additionally, monitoring ensures accountability of decision-makers and leaders, detects problems and constraints related to interventions, and promotes evidence-based planning through timely feedback to the relevant authorities. Indicators of inputs, processes and outputs are typically used for monitoring purposes at the program level. Input indicators are generally used to measure the level of resources available for use by the program or intervention, such as the funding to purchase ITNs. Process indicators are generally used to verify that a program or intervention is implemented as planned, such as verifying that ITNs are purchased and ready for distribution. It is expected that inputs and desired processes will lead to changes in output indicators, which are generally used to measure benchmarks of program-level performance, such as the number of ITNs distributed to a particular target population. Figure 1 provides an example schematic of the level and function of indicators typically used for M&E. While monitoring generally collects data on a regular basis (weekly, monthly, quarterly or annually), evaluation occurs over a longer time frame.

Figure 1: Level and Function of Monitoring and Evaluation Indicators



While monitoring is a continuous process that serves to inform programmatic decision-making, evaluation is undertaken at discrete points of time, typically every few years. Evaluation may assess whether activities have been undertaken as planned (normative evaluation) or may seek to determine whether changes in results are attributable to a particular malaria control program, as measured through outcome and impact indicators. Such evaluation is known as impact evaluation. Impact evaluation involves measuring changes in impact level indicators, such as morbidity and mortality, and empirically linking the observed change with a specific program or intervention. This type of evaluation requires rigorous experimental design to make a causal association between program inputs and resulting impacts. In the field of public health, where programs operate in the context of existing communities and not in controlled trial settings, evaluators must use observational evidence to make inferences about causality. Difficulties in measuring malaria-specific morbidity and mortality consistently over time present further challenges to conducting impact evaluations.

For these reasons, emphasis is often placed on measuring changes in indicators at the outcome level, such as the level of ITN utilization among a particular target population that can be attributed to a program. There is substantial empirical evidence to support the efficacy of current technical strategies in different programmatic contexts. Hence, it is expected that increasing coverage of these key interventions will result in the desired reductions in morbidity and mortality. It is, therefore, crucial that countries implementing these interventions have clear definitions and appropriate tools for measuring the outcome indicators for population-level coverage as part of their overall monitoring and evaluation strategy.

This guide provides basic information for measuring a selection of impact indicators, in order to allow countries to assess whether scale-up of the key interventions has resulted in the intended impact at the population level over the longer term. Assessing key interventions at the population level through population-based surveys can be very useful in making comparisons over time within and across countries.

2.2 Household Surveys

Nationally representative, population-based household surveys are a principal measurement tool to collect data for measuring outcome and impact indicators. These surveys complement routine data collection carried out by national governments and national malaria control programs (NMCP). Three large survey efforts that currently collect data on malaria are the Demographic and Health Survey (DHS), the Multiple Indicator Cluster Survey (MICS) and the Malaria Indicator Survey (MIS).

Demographic and Health Surveys: DHS surveys are nationally representative, population-based household surveys that are routinely undertaken every four to five years to collect data on a wide variety of demographic and health indicators. Since the inception of DHS in 1985, more than 275 DHS surveys have been conducted in more than 90 countries. DHS surveys are designed to produce data that are comparable over time and across countries. DHS surveys include a household listing to ascertain the age, sex and relationship to the head of household for all individuals within selected households. The surveys are typically designed to provide relatively precise population-level estimates by age groups, sex, urban/rural residence and regions. DHS surveys include malaria-related questions that are required for the calculation of the indicators in this manual. Published reports, questionnaires and materials related to DHS surveys can be found online at http://www.measuredhs.com.

Multiple Indicator Cluster Surveys: MICS surveys are nationally representative, population-based household surveys developed by the United Nations Children's Fund (UNICEF) to support countries in filling critical data gaps for monitoring the situation of children and women. Initially designed to collect indicators marking progress

towards the World Summit for Children goals, MICS surveys have been an important component of national data collection in many countries. MICS surveys are currently conducted in rounds approximately every three years, and since its inception in 1995, 240 surveys have been conducted in approximately 100 countries worldwide. MICS surveys are designed to produce data that are comparable over time and across countries and are harmonized with data collected through other major household survey programs, such as DHS and MIS. The MICS survey package includes a module for malaria that allows the collection of necessary data for the construction of the indicators in this manual. However, a full net roster and ITN use among pregnant women were not included prior to Round 4 (2009-2011) of the MICS surveys. Published reports, questionnaires and datasets related to the MICS surveys can be found online at http://www.childinfo.org.

Malaria Indicator Surveys (MIS): In addition to the ongoing survey efforts of DHS and MICS, RBM partners have developed a standard MIS package for assessing the key household coverage indicators and morbidity indicators. This includes a core questionnaire and data tabulation plan, as well as related materials for organizing and conducting fieldwork. This stand-alone survey is designed to be implemented in a similar manner to the DHS surveys, producing nationally representative, population-based data from which most indicators in this manual can be constructed. The MIS surveys also produce a wide range of data for in-depth assessment of the malaria situation within countries. At the time of this publication, more than 25 national MIS surveys have been completed. Information about these surveys can be found online at http://www.malariasurveys.org. The MIS survey questionnaire and other related materials can be found online at http://www.rbm.who.int/toolbox/tool_MISToolkit.html.

It is recommended that the indicators described in this document be measured using either the DHS or MICS surveys because of their sampling design rigor and reliability over time and across countries. Furthermore, a comprehensive package of demographic and health data is collected during both of these surveys, which allows additional analyses to be conducted. However, these surveys are only implemented every three to five years. If immediate data collection is required that does not fit within the implementation schedule of either the DHS or MICS surveys for a particular country, it is recommended that the MIS survey be used to obtain the necessary data for measuring the indicators. This will ensure their comparability with the DHS and MICS surveys over time and across countries, subject to considerations of the seasonality of malaria transmission discussed in Section 2.4.

2.3 Sampling

To ensure that indicators and their accompanying standard errors can be measured accurately, it is recommended that sampling procedures follow similar methods to those used by the DHS, MICS or MIS surveys. Such procedures typically entail a two-stage cluster sampling design with primary sampling units selected with probability proportional to size. Additionally, these samples are typically stratified by region, and by urban/rural residence, as stipulated by survey objectives. For further details of this general type of sampling method, please refer to the sampling guidelines for the DHS, MICS or MIS surveys.

To remain consistent with global targets, the coverage indicators are intended to be measured among the population “at risk for malaria,” which in some instances may create complications for survey design.

Both the DHS and MICS surveys typically include all primary sampling units for an entire country in their sampling frames to ensure nationally representative estimates. In countries with endemic or epidemic-prone malaria throughout, it is indeed appropriate to include all primary sampling units within the country in the sampling frame, given that pre-stratification by urban and rural residence is also undertaken. However, if a DHS or MICS survey is

used to measure the indicators in countries with defined areas without endemic or epidemic-prone malaria, such as those with mountainous areas or deserts, it should be noted that national estimates will include populations not at risk for malaria. This will need to be taken into account when interpreting the values of national-level indicators for some countries. Please refer to the **MIS Sampling Guidelines** for a more detailed description of how best to construct a sampling frame for countries with widely varying levels of malaria endemicity. It is available at http://www.rbm.who.int/toolbox/tool_MISToolkit.html.

2.4 Interpretation

There are two particular issues that can affect the interpretation of results obtained from household surveys.

Malaria Endemicity

The first issue that may affect the interpretation of the values of indicators involves the definition of the target population. As stated previously, the RBM targets stipulate that the coverage indicators are intended to be measured among the target population defined as those at risk for malaria. For countries in which malaria is endemic or epidemic-prone throughout, this issue should not be of particular concern as long as stratification by urban and rural residence is undertaken, as is typically the case with the DHS, MICS and MIS surveys. However, within countries that contain large populations in areas absent of malaria, such as those with mountainous areas or deserts, national-level estimates, such as those obtained from the DHS and MICS surveys, will likely result in an underestimate of coverage for those at risk for malaria. In such a situation, it may be advisable to collect additional information that can establish whether an enumeration area is within or outside a malaria risk area; then, during data analysis one can limit the analysis to survey domains that are deemed to be malarious.

Despite the difficulties associated with varying levels of endemicity, progress in malaria intervention coverage is generally monitored at the national level in high-burden countries in Africa, rather than among sub-national at-risk populations. There are many important reasons for relying on national-level estimates of malaria intervention coverage. For many countries, it is difficult to accurately define at-risk areas and subsequently to identify households surveyed within those areas since surveys do not always geo-code the households or villages where survey interviews occur [7] or the geo-codes are randomly offset to protect confidentiality. Additionally, the at-risk population will continue to change, and therefore it would be difficult to measure progress with the indicators proposed. Finally, if a strategy is being implemented in an effort to achieve elimination, high coverage levels must be sustained at the national level in order to continue to control malaria and prevent against future resurgence.

Consequently, indicator estimates obtained from DHS and MICS surveys will not be expected to correspond specifically to malaria endemic areas, but will be nationally-representative, even in those countries with non-malarious regions. The MIS guidelines should be consulted in order to incorporate an appropriate subsampling design in countries which include non-malarious regions.

Seasonality

A second consideration that affects the interpretation of the survey findings is the timing of survey implementation relative to the malaria transmission season (rainy and early post-rainy seasons). Generally speaking, MIS surveys are conducted during and immediately after the rainy season and should end no later than four to six weeks after the rains end, as this timeframe is associated with peak transmission. However, for

operational reasons, both DHS and MICS surveys are typically conducted during the dry season and therefore outside of the peak malaria transmission period. As intervention coverage or usage levels may differ significantly between seasons, and malaria morbidity and mortality will differ by season, interpretation of the data obtained must take into account the seasonality of the survey period. It is also important to note that parasite prevalence data from surveys conducted outside of peak transmission periods is not a reliable indicator of peak transmission; therefore, biomarker measurement is recommended only during the malaria transmission season. Further analysis of these data is needed to better understand the extent of the relationship between survey timing and intervention coverage. Notes on significant assumptions and potential biases associated with specific indicators are provided separately in Section 4, under the description of each indicator.

3. Guidelines for Constructing Indicators from Household Surveys

3.1 Prevention Using Insecticide-treated Nets and Indoor Residual Spraying

At full coverage under trial conditions, ITNs have been shown to reduce all-cause child mortality by 17 percent in sub-Saharan Africa and uncomplicated malaria cases among children under five by 50 percent across a range of malaria transmission settings [8]. ITNs also appear to display similar effectiveness under field conditions [9]. Efforts to scale up coverage of ITNs to reach universal utilization among the population at risk of malaria are underway in most African countries [1].

There are two categories of ITNs: conventionally-treated nets and long-lasting insecticidal nets (LLIN). Conventionally treated nets are mosquito nets that have been soaked with an insecticide within the past 12 months. An LLIN is a factory-treated net that does not require any treatment. It is designed to maintain efficacy against mosquito vectors for at least three years. Since 2007, WHO has recommended that malaria control programs and their partners procure only LLINs [10]. For the purpose of these guidelines, LLINs and conventionally-treated nets are included in the category of ITNs. **Past editions of this guidance noted that pretreated nets were also commonly included in data collection as a separate type of net and could be considered either an ITN or not, depending on date of purchase and timing of last insecticide retreatment. As pretreated nets are rarely distributed anymore, this category has been removed from the current version of these guidelines and the core MIS questionnaire.** However, in countries where these nets are still available, this category of nets should be included in the MIS questionnaire for the purpose of calculation of indicators. While untreated nets can still sometimes be found in markets in a few countries, they are not considered part of a formal malaria prevention strategy.

Since 2007, WHO has recommended that ITNs be made available to all people at risk, regardless of age, i.e., universal access [10]. In assessing universal access, it is assumed that two people can sleep under one ITN. Given the new focus on achieving universal access to and utilization of ITNs, the following three new indicators have been recommended:

- *Proportion of households with at least one ITN for every two people*
- *Proportion of population with access to an ITN in their household*
- *Proportion of population who slept under an ITN the previous night*

IRS is the organized, timely spraying of an insecticide on the inside walls of houses or dwellings. It is designed to interrupt malaria transmission by killing adult female mosquitoes that enter houses and rest on walls after feeding but before they transmit the infection to another person [11]. IRS has been shown to be effective in reducing vectorial capacity and malarial disease in a wide variety of settings; it is particularly effective in locations where mosquitoes are indoor-resting and malaria is seasonally transmitted [12]. IRS is often conducted in smaller communities rather than entire districts or cities.

A new indicator is included to measure universal coverage of vector control. By including ITN and IRS interventions in a single indicator, one can assess universal coverage of preventive control measures within a country, or conversely, the percentage of the population not fully covered by either strategy.

- *Proportion of households with at least one ITN for every two people and/or sprayed by IRS within the last 12 months*

Table 5: Summary of Vector Control Indicators

Indicator	Purpose/Rationale of Indicator
1. Proportion of households with at least one ITN	Measures household ITN ownership.
2. Proportion of households with at least one ITN for every two people **(NEW)**	Measures the proportion of households that have a sufficient number of ITNs to cover all individuals who spent the previous night in surveyed households, assuming each ITN is shared by two people. It is useful for determining what proportion of households has achieved universal coverage with ITNs. In comparison with the previous indicator, it describes the intra-household ownership gap, i.e., households which own at least one ITN, but have not achieved universal coverage.
3. Proportion of population with access to an ITN in their household **(NEW)**	Provides an estimate of the proportion of the population that could have slept under an ITN assuming each ITN is used by two people.
4. Proportion of the population that slept under an ITN the previous night **(NEW)**	Measures the level of ITN use among all individuals who spent the previous night in surveyed households, regardless of whether those individuals had access to an ITN within their household. It can be broken down by five-year age brackets, gender, etc., for programmatic analysis. This indicator can be compared with the proportion of population with access to an ITN in their household to describe the magnitude of the behavioral gap in use of ITNs, i.e., the population with access to an ITN, but not using it. This analysis is useful for informing ITN programs whether they need to focus on achieving higher ITN coverage, promoting ITN use or both.
5. Proportion of children under five years old who slept under an ITN the previous night	Measures the level of ITN use of children under five years old.
6. Proportion of pregnant women who slept under an ITN the previous night	Measures the level of ITN use by pregnant women.
7. Proportion of existing ITNs used the previous night **(NEW)**	Measures the use of existing ITNs. In certain instances, calculating the proportion of existing ITNs used the previous night will be useful for assessing the utilization of existing ITNs and determining the magnitude of non-use of ITNs at the time of the survey.
8. *Households covered by vector control*: Proportion of households with at least one ITN and/or sprayed by IRS in the last 12 months	Measures the proportion of household covered by an ITN and/or IRS. This indicator may be more appropriate in places where IRS is limited to small target areas, as it provides an assessment of the vector control activities being conducted throughout the country as opposed to measuring only national coverage of IRS activities.
9. *Universal coverage of vector control*: Proportion of households with at least one ITN for every two people and/or sprayed by IRS within the last 12 months **(NEW)**	Aims to assess progress towards achievement of universal coverage of malaria prevention through the two main vector control activities.

Table 6 provides details on the strengths and limitations of all ITN indicators.

Table 6: Strengths and Limitations of All ITN Indicators

Strengths	▪ The household net roster can be used to collect data for all of these indicators and can be added to any nationally representative sample survey of households. ▪ Presence of a net is typically verified at time of interview. ▪ Comparability across countries given that appropriate and consistent sampling procedures are followed and confounding factors are accounted for.
Limitations	▪ Not all ITNs found in the household are fit for use. ▪ May not provide reliable estimates of net retreatment status for ITNs either because the respondent is not aware of retreatment of the ITN or does not correctly recall the timing of last ITN retreatment. ▪ Typically, no information is collected on whether the insecticide used to treat the net is an “approved” insecticide. ▪ No information is collected on whether the net was washed after treatment, which can reduce its effectiveness. ▪ May be difficult to interpret at the national level unless stratified by region and urban/rural strata as malaria transmission is most often localized.

1. Proportion of Households with at Least One ITN[3]

- **Numerator:** Number of households surveyed with at least one ITN
- **Denominator:** Total number of households surveyed

Purpose/Rationale

This indicator measures household ITN ownership.

Method of Measurement

The numerator for this indicator is obtained from asking the household respondent if there is any mosquito net in the house that can be used while sleeping and from determining whether each net found in a household is a factory-treated net that does not require any treatment (an LLIN) or a net that has been soaked with insecticide within the past 12 months. The denominator is the total number of surveyed households.

Interpretation

This indicator provides a measure for household ownership of an ITN. It reflects the extent to which ITN programs have reached all households or, conversely, the proportion of households not yet reached.

[3] An ITN is 1) a factory-treated net that does not require any treatment (an LLIN) or 2) a net that has been soaked with insecticide within the past 12 months (see Reference Section 3.1 for explanation of the revised definition).

2. Proportion of Households with at Least One ITN[4] for Every Two People

- **Numerator**: Number of households with at least one ITN for every two people
- **Denominator**: Total number of households surveyed

Purpose/Rationale

This indicator is used to determine the proportion of households with a sufficient number of ITNs to protect all individuals in the household.

Method of Measurement

The data for the numerator are obtained from determining whether each net found in a household is a factory-treated net that does not require any treatment (an LLIN) or a net that has been soaked with insecticide within the past 12 months and then calculating the total number of ITNs in the household, in combination with information obtained from the household questionnaire that lists the number of individuals who spent the previous night in surveyed households.

The numerator is calculated by dividing the number of individuals who spent the previous night in each surveyed household by the number of ITNs owned by the household and then identifying those households that have a *people to ITN ratio* of 2.0 or less. The denominator is simply the total number of surveyed households.

Considerations

This indicator is based on the assumption that two people can sleep under one ITN.

Interpretation

In connection with the previous indicator (proportion of households with at least one ITN), it can be used to determine what proportion of households already reached with at least one ITN has a sufficient number of ITNs to protect all members in the household. If the difference between these indicators is substantial, programs need to assess whether current ITN distribution strategies should be revised to fill the gap.

[4] An ITN is 1) a factory-treated net that does not require any treatment (an LLIN), or 2) a net that has been soaked with insecticide within the past 12 months (see Reference Section 3.1 for explanation of revised definition).

3. Proportion of Population with Access to an ITN[5] within their Household

- **Numerator**: Total number of individuals who could sleep under an ITN if each ITN in the household is used by two people
- **Denominator**: Total number of individuals who spent the previous night in surveyed households

Purpose/Rationale

This indicator estimates the proportion of the population that could potentially be covered by existing ITNs, assuming that each ITN in a household can be used by two people within that household. It can be compared with Indicator 4, which measures the proportion of population who slept under an ITN the previous night, to assess the extent to which available ITNs are used (i.e., the population with access to an ITN, but not using it). This analysis is useful for informing ITN programs whether they need to focus on achieving higher ITN coverage, promoting ITN use or both.

Method of Measurement

The data for the numerator are obtained from determining whether each net found in a household is a factory-treated net that does not require any treatment (an LLIN) or a net that has been soaked with insecticide within the past 12 months and then calculating the total number of ITNs in the household.

The data for the denominator are obtained from the household questionnaire that lists all individuals who spent the previous night in surveyed households.

The calculation needs an intermediate variable which is "potential users." It can be calculated by multiplying the number of ITNs in each household by two. In households which have more than one ITN for every two people, the product of this calculation will be greater than the number of individuals who spent the previous night. In this case, the "potential users" variable in that household should be modified to reflect the number of individuals who spent the previous night in the household because the number of potential users in a household cannot exceed the number of individuals who spent the previous night in that household. For example, in a household with ten people and four ITNs, there are eight potential users; however, in a household with five people and four ITNs, there are five potential users even though the number of ITNs available could cover more than five people.

The indicator can then be calculated by dividing the sum of all potential ITN users in the sample by the total number of individuals who spent the previous night in surveyed households. An example of the Stata® and code used to calculate this indicator is provided in Annex 2.

[5] An ITN is 1) a factory-treated net that does not require any treatment (an LLIN), or 2) a net that has been soaked with insecticide within the past 12 months (see Reference Section 3.1 for explanation of revised definition).

Considerations

This indicator is based on the assumption that two people can sleep under one ITN. For example, a household with six residents will require three ITNs. It excludes surplus ITNs in households which have more than one ITN for every two people.

Interpretation

This indicator provides an estimate of the proportion of the total population that could have slept under an ITN. This indicator can be compared with the proportion of the population sleeping under an ITN the previous night (Indicator 4). If the difference between these indicators is substantial, the program may need to focus on identifying the main drivers or barriers to ITN use in order to design an appropriate intervention for behavior change.

4. Proportion of Population that Slept under an ITN[6] the Previous Night

- **Numerator**: Number of individuals who slept under an ITN the previous night
- **Denominator**: Total number of individuals who spent the previous night in surveyed households

Purpose/Rationale

This indicator measures the level of ITN use of all age groups at the time of the survey. It is useful to track usage among all ages since coverage of entire populations will be required to accomplish large reductions of malaria burden.

Method of Measurement

The data for the denominator are obtained from the household questionnaire that lists all individuals who stayed in the household the previous night. The data for the numerator are then obtained from a listing of the same individuals in the house who slept under a mosquito net the previous night, in combination with information on whether it is a factory-treated net that does not require any treatment (an LLIN) or a net that has been soaked with insecticide within the past 12 months.

Considerations

This indicator may be biased by the seasonality of survey data collection, since survey fieldwork for DHS and MICS is most often done during the dry season when net use is likely at its lowest.

Interpretation

This indicator provides a direct measure of ITN use by all age groups at the time of the survey. It includes all individuals who spent the previous night in surveyed households, including visitors, regardless of whether those individuals had access to an ITN within their own households.

In connection with Indicator 3 (proportion of individuals that have access to an ITN within the household), this indicator can be used to define the behavioral gap in use of ITNs (i.e., the population with access to an ITN but not using it) and distinguish it from the ownership gap (i.e., non-use because there are not enough nets in the household).

[6] An ITN is 1) a factory-treated net that does not require any treatment (an LLIN), or 2) a net that has been soaked with insecticide within the past 12 months (see Reference Section 3.1 for explanation of revised definition).

5. Proportion of Children under Five Years Old Who Slept under an ITN[7] the Previous Night

- **Numerator**: Number of children under five years old who slept under an ITN the previous night
- **Denominator**: Total number of children under five years old who spent the previous night in surveyed households

Purpose/Rationale

This indicator is used to measure the level of ITN coverage of children under five years old at the time of the survey.

Method of Measurement

The data for the denominator are obtained from the household questionnaire that lists every child under five who stayed in the house the previous night. The data for the numerator are then obtained from a listing of the same children in the house who slept under a mosquito net the previous night, in combination with information on whether it is a factory-treated net that does not require any treatment (an LLIN) or a net that has been soaked with insecticide within the past 12 months.

Considerations

This indicator may be biased by the seasonality of survey data collection, since survey fieldwork for DHS and MICS is most often done during the dry season when net use is likely at its lowest.

Interpretation

This indicator provides a direct measure of ITN use by children under five years of age at the time of the survey.

[7] An ITN is 1) a factory-treated net that does not require any treatment (an LLIN), or 2) a net that has been soaked with insecticide within the past 12 months (see Reference Section 3.1 for explanation of revised definition).

6. Proportion of Pregnant Women Who Slept under an ITN[8] the Previous Night

- **Numerator:** Number of pregnant women who slept under an ITN the previous night
- **Denominator:** Total number of pregnant women within surveyed households

Purpose

This indicator is used to measure the level of ITN use by pregnant women.

Method of Measurement

The data for the denominator are obtained from a question asked of all interviewed women of reproductive age in the household about their current pregnancy status. The data for the numerator are then obtained from a listing of these women who slept under a mosquito net the previous night, in combination with information on current pregnancy status and whether the net is a factory-treated net that does not require any treatment (an LLIN) or a net that has been soaked with insecticide within the past 12 months.

Note that the MICS survey program did not collect data for this indicator prior to the inclusion of the household net roster in Round 4 (2009-2011).

Considerations

This indicator may be biased by the seasonality of survey data collection, since survey fieldwork for DHS and MICS is most often done during the dry season when net use is likely at its lowest.

Additionally, it is difficult to capture data on all pregnant women in a household survey because many women either don't know they are pregnant or may not want to divulge this information during early pregnancy. There may be some bias if any reluctance to discuss pregnancy is also associated with first births, adolescence and other demographic factors.

Interpretation

This indicator provides a direct measure of ITN use by pregnant women at the national level.

[8] An ITN is 1) a factory-treated net that does not require any treatment (an LLIN), or 2) a net that has been soaked with insecticide within the past 12 months (see Reference Section 3.1 for explanation of revised definition).

7. Proportion of Existing ITNs[9] Used the Previous Night

- **Numerator:** Number of ITNs in surveyed households that were used by anyone the previous night
- **Denominator:** Total number of ITNs in surveyed households

Purpose/Rationale

This indicator measures the use of existing ITNs. In certain instances, calculating the proportion of existing ITNs used the previous night is useful for assessing the utilization of existing ITNs and determining the magnitude of non-use of ITNs at the time of the survey.

Method of Measurement

The data for the denominator are obtained from the household questionnaire that lists every ITN in each surveyed household. The data for the numerator are then obtained from a listing of every ITN and information on whether the ITN was used by anyone who stayed in the household the previous night.

Considerations

This indicator may be biased by the seasonality of survey data collection, since survey fieldwork for DHS and MICS is most often done during the dry season when net use is likely at its lowest.

Interpretation

This indicator provides a direct measure of use of existing ITNs at the time of the survey. It complements indicators referring to the potential and actual ITN use in the population, provides an assessment of the level of non-use of ITNs, and identifies behavioral deficiencies of ITN use.

This indicator does not account for the possibility that some households may have an oversupply of ITNs or that some individuals may have slept outside of the household the previous night. In households where there are more ITNs than individuals sleeping in the household, not all ITNs will have been used the previous night.

[9] An ITN is 1) a factory-treated net that does not require any treatment (an LLIN), or 2) a net that has been soaked with insecticide within the past 12 months (see Reference Section 3.1 for explanation of revised definition).

8. Households Covered by Vector Control

Proportion of Households with at Least One ITN[10] and/or Sprayed by IRS in the Last 12 Months

- **Numerator:** Number of households that have at least one ITN and/or have been sprayed by IRS in the last 12 months
- **Denominator:** Total number of households surveyed

Purpose/Rationale

This indicator assesses the extent to which the two main vector control activities are available to populations. It measures the proportion of households covered by either an ITN or IRS. In places where IRS is limited to small target areas, this indicator provides a more appropriate assessment of the vector control activities being conducted throughout the country than an indicator measuring national coverage of IRS activity alone.

Method of Measurement

The data for the numerator are obtained from information on which households possess an ITN and which households have been protected by IRS in the last 12 months. The denominator is simply the total number of households in the survey.

An IRS campaign may be conducted either as part of the national strategy for malaria control (operations conducted by governmental spray teams) or undertaken by a non-governmental organization (NGO) or private company. It is important to capture only those spraying activities that have occurred as part of an organized IRS campaign and to exclude spraying that was conducted by a member of the household.

Considerations

Asking respondents to recall when the household was sprayed can result in considerable bias and 'heaping' of dates. The estimate may be biased upwards if the respondent confuses spraying with residual insecticide with spraying with household products; however, such confusion can be reduced by thoroughly training interviewers. Additionally, bias can result because the actual respondent may not have been present at the time of spraying and may therefore be reporting what was heard from others.

Interpretation

This indicator provides a measure of national vector control activities. It should not be confused with programmatic surveys that capture whether IRS activities reached all their target households. This indicator supports the interpretation of indicator 9, universal coverage of vector control.

[10] An ITN is 1) a factory-treated net that does not require any treatment (an LLIN), or 2) a net that has been soaked with insecticide within the past 12 months (see Reference Section 3.1 for explanation of revised definition).

9. Universal Coverage of Vector Control

Proportion of Households with at Least One ITN[11] for Every Two People and/or Sprayed by IRS within the Last 12 Months

- **Numerator:** Number of households with at least one ITN for every two people and/or have been sprayed by IRS in the last 12 months
- **Denominator:** Total number of households surveyed

Purpose/Rationale

This indicator allows universal coverage of vector control activities to be assessed. Universal coverage of vector control means that each person in a specified geographic area at risk of malaria is protected from malaria infection by either owning an ITN or by living in a house protected by IRS.

Method of Measurement

The data for the numerator are obtained from information on the total number of households with at least one ITN for every two people, in combination with information on whether the households have been sprayed by IRS in the last 12 months. The denominator is simply the total number of households in the survey.

An IRS campaign may be conducted either as part of the national strategy for malaria control (operations conducted by governmental spray teams) or undertaken by an NGO or private company. It is important to capture only those spraying activities that have occurred as part of an organized IRS campaign and to exclude spraying that was conducted by a member of the household.

Considerations

This indicator seeks to avoid double counting the number of persons protected by both IRS and ITNs.

Asking respondents to recall when the household was sprayed can result in considerable bias and 'heaping' of dates. The estimate may be biased upwards if the respondent confuses spraying with residual insecticide with spraying with household products; however, such confusion can be reduced by thoroughly training interviewers. Additionally, the bias can result because the actual respondent may not have been present at the time of spraying and may therefore be reporting what was heard from others.

Interpretation

This indicator aims to assess progress towards achievement of universal coverage of malaria prevention through the two main vector control activities.

[11] An ITN is 1) a factory-treated net that does not require any treatment (an LLIN), or 2) a net that has been soaked with insecticide within the past 12 months (see Reference Section 3.1 for explanation of revised definition).

Additional Analysis: IRS National-level Indicator

Proportion of Households that Received Spraying through an IRS Campaign within the Last 12 Months

- **Numerator:** Number of households that were sprayed with a residual insecticide during an IRS campaign in the last 12 months
- **Denominator:** Total number of households surveyed

Purpose/Rationale

The purpose of this indicator is to measure IRS coverage at the national level. The intent is to obtain information on overall coverage with IRS, rather than information on the quality of spraying activities. In countries where sizeable IRS operations are underway, it may be advantageous to report IRS coverage at the national level. In some countries, relatively small areas or 'target zones' are specifically targeted for spraying, so presenting nationally representative results may misrepresent the extent to which IRS targets have been achieved, as low nationwide coverage is not necessarily an indication of a poorly-performing IRS program. However, these data are necessary to collect in order to calculate the indicators, households covered with vector control and universal coverage of vector control. Furthermore, it may be deemed necessary to report on this indicator in certain countries due to reporting requirements, to ensure consistency between years and/or due to sampling considerations.

Method of Measurement

Household survey questions for measuring population-level IRS coverage from a DHS, MICS or MIS survey can be used to obtain the necessary information. This indicator can therefore be constructed from any household survey which includes such questions and covers areas where spraying is expected to have occurred.

An IRS campaign may be conducted either as part of the national strategy for malaria control (operations conducted by government spray teams) or by an NGO or private company (operations conducted independent of the national strategy). It is important to capture only those spraying activities that have occurred as part of an organized IRS campaign, rather than spraying that was conducted by a member of the household.

The ideal household survey would be one which has coverage sufficient to include a large proportion of all areas intended for spraying by the national program. If the household survey used for collecting data for this indicator does not specifically use a survey population, defined as those at risk for malaria, care must be taken to ensure that a sufficient sample size is obtained within malaria endemic areas of the country. It may also be necessary to oversample within districts with known levels of malaria transmission and known levels of IRS activity for comparison purposes and to aid with interpretation.

Considerations

Asking respondents to recall when the household was sprayed can result in considerable bias and 'heaping' of dates. The estimate may be biased upwards if the respondent confuses spraying with residual insecticide with spraying with household products; however, such confusion can be reduced by thoroughly training interviewers. Furthermore, bias can result because the actual respondent may not have been present at the time of spraying and may therefore be reporting what was heard from others.

Interpretation

This indicator provides an estimate of IRS coverage at the national level over a 12-month time period. Since data are obtained from household surveys, careful interpretation of the results in required, given that achieving high levels of IRS coverage at the national level is not always the intent of programs.

Furthermore, since the denominator does not specifically exclude those areas not covered by a program, this indicator cannot be used to evaluate the *performance* of a national IRS program. Likewise, this estimate is nationally representative and may not adequately capture program efforts in targeted subnational areas.

Program-level IRS Indicators

Reliable program data, obtained during routine spraying activities, are crucial for evaluating the performance of IRS programs. Given that household survey data have limitations such as recall bias, and results at the national level may be misleading, program data should be collected in order to more accurately assess the progress achieved by spraying programs. To facilitate this process, program-level indicators may need to be reported as part of the national-level monitoring and evaluation plan.

3.2 Intermittent Preventive Treatment during Pregnancy

Malaria infection during pregnancy is a major public health concern in malaria endemic areas with stable transmission, such as tropical Africa. Malaria during pregnancy can result in poor outcomes for the woman and her newborn, such as maternal anemia, low birth weight, and premature delivery [13]. Low birth weight is the single greatest risk factor for neonatal mortality and a major contributor to infant mortality [14, 15]. This increased risk of adverse outcomes for mothers and their newborns is typically greatest for the mother's first two pregnancies. However, in the presence of HIV infection, the risk associated with placental malaria appears to be independent of the number of pregnancies [16].

Effective strategies for preventing and controlling malaria during pregnancy, such as the use of ITNs and IPTp, have been shown to have a dramatic impact on the health of mothers and their newborns within areas of stable malaria transmission. ITN use has been shown to significantly reduce the prevalence of low birth weight deliveries, as well as malaria-related morbidity among pregnant women [13, 17] (see page 24 for an indicator on use of ITNs in pregnancy).

IPT is the administration of a full course of an effective antimalarial treatment at specified time points to a defined population at risk of malaria, regardless of whether they are parasitemic, with the objective of reducing the malaria burden in the specific target population. WHO currently recommends IPTp with sulfadoxine-pyrimethamine (SP) at each scheduled antenatal care visit for pregnant women living in areas of moderate to high transmission in sub-Saharan Africa. The first IPTp-SP dose should be administered as early as possible during the 2nd trimester of pregnancy. Each SP dose should be given at least 1 month apart and the last dose can be administered up to the time of delivery [6]. IPTp has been shown to significantly reduce the prevalence of anemia and placental malaria infections at the time of delivery [18-20]. However, SP is contraindicated in HIV+ women already receiving co-trimoxazole as chemoprophylaxis [5].

Studies are underway to determine the continued safety and efficacy of IPTp using SP, given the recent increase in SP resistance [21]. To date, SP has been shown to provide substantial benefit to pregnant women even in settings where resistance has been observed [22].

As the WHO recommendation regarding the frequency of IPTp was recently updated, the IPTp indicator in this document has been changed to measure three or more doses rather than two or more doses to reflect the new policy.

10. Proportion of Women who Received Three or More Doses of Intermittent Preventive Treatment during ANC Visits during Their Last Pregnancy

- **Numerator:** Number of women who received three or more doses of a recommended prophylactic antimalarial drug treatment, at least one of which was received during an ANC visit, to prevent malaria during their last pregnancy that led to a live birth within the last two years
- **Denominator:** Total number of women surveyed who delivered a live baby within the last two years

Purpose

WHO recommends that all pregnant women in areas of moderate to high malaria transmission in sub-Saharan Africa receive SP at each scheduled ANC visit, with at least one month between each dose, beginning as early as possible in the second trimester of pregnancy [6]. This indicator is used to measure the use of IPTp to prevent malaria during pregnancy among women who gave birth in the last two years.

Method of Measurement

Data from the women's questionnaires for all women in surveyed households who delivered a live baby within the last two years are used to calculate the denominator. The numerator is derived from the number of women who mention taking a recommended prophylactic antimalarial drug, at least one dose of which was received during an ANC visit, for prevention (not treatment) during their most recent pregnancy (from among all listed births to women in the last two years).

The currently recommended drug for IPTp is SP. In order to obtain accurate data for this indicator, it is important to differentiate between a treatment dose for prevention (as prescribed for IPTp) and actual treatment of an existing malaria infection. Although it is difficult to differentiate in the context of a survey interview, the latter is curative care and does not count as a standard IPTp procedure. Therefore, women taking antimalarial drugs, such as ACTs, which are not part of standard IPTp, should be not be considered as covered by IPTp. Similarly, women taking weekly chloroquine prophylaxis are not considered to be covered by IPTp.

Considerations

IPTp with SP is currently only recommended by WHO for stable transmission areas in sub-Saharan Africa [6]. This indicator does not provide information regarding at which stage during pregnancy IPTp was given. Household surveys do not typically measure whether each dose of IPTp was given during antenatal care visits. They can only be used to determine whether at least one of the doses received was given during an ANC visit.

Retrospective questions about IPTp given during a previous pregnancy may be subject to recall bias. For example, a woman may not recall which type of antimalarial was given or how many doses she received.

Additionally, it is difficult to capture data on all pregnant women in a household survey because many women either do not know they are pregnant or may not want to divulge this information during early pregnancy. There

may be some bias if any reluctance to discuss pregnancy is also associated with first births, adolescence and other factors.

Interpretation

This indicator provides a measure of the proportion of pregnant women who receive IPTp during pregnancy. As the WHO recommendation regarding the frequency of IPTp was recently updated, the IPTp indicator in this document has been changed to measure three or more doses rather than two or more doses during ANC visits to reflect the new policy. Data on one, two and four or more doses of IPTp can aid in the interpretation of this indicator.

Additional Analysis: Proportion of women who received at least one, two, or four doses of a recommended prophylactic antimalarial drug treatment, at least one of which was received during an ANC visit, to prevent malaria during their last pregnancy that led to a live birth within the last two years

- **Numerator:** Number of women who received at least one, two, or four doses of a recommended prophylactic antimalarial drug treatment, at least one of which was received during an ANC visit, to prevent malaria during their last pregnancy that led to a live birth within the last two years
- **Denominator:** Total number of women surveyed who delivered a live baby within the last two years

Purpose/Rationale

WHO recommends that all pregnant women in areas of moderate to high malaria transmission in sub-Saharan Africa receive SP at each scheduled ANC visit, with at least one month between each dose, beginning as early as possible in the second trimester of pregnancy [6]. This indicator is used to disaggregate the measure of various doses (one, two and four) of IPTP to prevent malaria during pregnancy among women who gave birth in the last two years.

Method of Measurement

Data from the women's questionnaires for all women in surveyed households who delivered a live baby within the last two years are used to calculate the denominator. The numerator is derived from the number of women who mention taking a recommended prophylactic antimalarial drug, at least one dose of which was received during an ANC visit, for prevention (not treatment) during their most recent pregnancy (from among all listed births to women in the last two years).

The currently recommended drug for IPTp is SP. In order to obtain accurate data for this indicator, it is important to differentiate between a treatment dose for prevention (as prescribed for IPTp) and actual treatment of an existing malaria infection. Although it is difficult to differentiate in the context of a survey interview, the latter is curative care and does not count as a standard IPTp procedure. Therefore, women taking antimalarial drugs, such as ACTs, which are not part of standard IPTp, should be not be considered as covered by IPTp. Similarly, women taking weekly chloroquine prophylaxis are not considered to be covered by IPTp.

Considerations

IPTp with SP is currently only recommended by WHO for stable transmission areas in sub-Saharan Africa [6]. This indicator does not provide information regarding at which stage during pregnancy IPTp was given. Household surveys do not typically measure whether each dose of IPTp was given during antenatal care visits. They can only be used to determine whether at least one of the doses received was given during an ANC visit.

Retrospective questions about IPTp given during a previous pregnancy may be subject to recall bias. For example, a woman may not recall which type of antimalarial was given or how many doses she received.

Additionally, it is difficult to capture data on all pregnant women in a household survey because many women either do not know they are pregnant or may not want to divulge this information during early pregnancy. There may be some bias if any reluctance to discuss pregnancy is also associated with first births, adolescence and other factors.

Interpretation

This indicator provides a dissagregated measure of the proportion of pregnant women who receive at least one, two and four doses of IPTp during pregnancy. Data on the various doses of IPTp can aid in the interpretation of indicator 10.

Health Management Information Systems as an Alternative Data Source

The primary disadvantage of surveys is that their results refer to pregnancies that occurred up to two years prior to the time of the survey (in order to base the estimates on a large enough number of cases). Measurement through health management information systems (HMIS) captures IPTp at the current time, and analyses can be targeted to facilities where IPTp is actually being implemented. Consequently, it is appropriate to collect data through both sources.

An IPTp indicator to be obtained from ANC registers is provided in the Malaria in Pregnancy: Guidelines for measuring key monitoring and evaluation indicators at:
http://whqlibdoc.who.int/publications/2007/9789241595636_eng.pdf. This indicator provides an alternative measure of IPTp delivered through ANC. It is important to note that a different denominator is used in the calculation of this indicator—pregnant women who access the health system; consequently, direct comparisons cannot be made between this indicator and the indicator described above.

3.3 Case Management (among Children under Five Years Old)

Access to Diagnostic Testing

Prompt parasitological confirmation by microscopy, or alternatively by rapid diagnostic tests (RDTs), is recommended in all patients with suspected malaria before treatment is started [5]. Antimalarial treatment given solely on the basis of clinical suspicion should only be considered when a parasitological diagnosis is not available. Treatment based on diagnostic testing is good clinical practice and has the following advantages over presumptive treatment of all fever episodes:

- Improved care of parasite-positive patients because of confirmation of infection;
- Identification of parasite-negative patients, in whom another diagnosis must be sought and treated accordingly;
- Reduced side effects, drug interactions, selection pressure and potentially costs by reducing use of antimalarial medicine in parasite-negative patients;
- Increased public trust in the efficacy of ACT when used only to treat confirmed malaria cases; and
- Enhanced public trust in diagnosis and treatment of non-malaria causes of febrile illness.

As malaria programs increase the coverage of interventions and the incidence of malaria decreases, the proportion of fevers not due to malaria increases. Hence, it becomes increasingly important to undertake diagnostic testing to identify and treat only confirmed cases.

Access to Effective Treatment

Prompt and effective treatment is a key element in successful malaria control because of the rapid onset of illness and severe health outcomes related to *Plasmodium falciparum* malaria, especially among children and non-immune populations [23, 24]. However, antimalarial drug resistance has become a major challenge in providing an effective malaria treatment in many regions of the world. Resistance to traditional monotherapies such as chloroquine, sulfadoxine-pyrimethamine and amodiaquine is widespread across most of Africa. As a result, WHO recommends treating malaria due to *P. falciparum* using ACTs [5]. Understanding which antimalarial drugs are provided to children and the promptness with which they seek treatment after the onset of symptoms is important for monitoring prompt access to effective treatment.

Although the treatment guidelines have shifted from presumptive treatment, measuring confirmed malaria cases among children under five through survey instruments presents a number of challenges. Caregivers may never receive the results of diagnostic testing, and if they do, they may not provide reliable information regarding malaria diagnoses. Due to these measurement challenges, the current version of this manual does not provide recommendations regarding the measurement of confirmed malaria cases, which would be the ideal basis for indicators related to prompt and effective treatment. Research is still needed to assess and improve methodologies to measure malaria cases through survey instruments. As an interim measure, the recommended indicator examines what proportion of antimalarial treatments are ACTs or other first-line treatments; first-line treatment is expected to include ACTs in most countries with *P.falciparum*, but may be different in countries with non-*falciparum* malaria. An indicator which measures the extent to which children with fever obtain a parasitological diagnosis is also recommended.

- *Proportion receiving any ACT (or other appropriatetreatment), among children under five years old with fever in the last two weeks who received any antimalarial drugs*
- *Proportion of children under five years old with fever in last two weeks who had a finger or heel stick*

A further indicator is also recommended:

- *Proportion of children under five years old with fever in the last two weeks for whom advice or treatment was sought*

These indicators replace those that were recommended in a previous version of this document, ***Guidelines for Core Population-Based Indicators***. The previously recommended treatment indicators were:

- *Proportion of children under five years old with fever in last two weeks who received any antimalarial treatment*
- *Proportion of children under five years old with fever in last 2 weeks who received antimalarial treatment according to national policy within 24 hours from the onset of fever*

These are presented in this document in Annex 1 as previously recommended indicators. The intention of the indicators was to capture the accessibility of antimalarial treatment to children under five years old with fever. The indicators have become problematic as diagnostic testing has scaled up; they do not take into account the fact that some febrile children will be given a diagnostic test and those that test negative should not be given an antimalarial medicine. As a result, countries or areas with more accessible health services and diagnostic testing can produce lower values of the indicator than those with weaker health services. In addition, for those children that are not tested, the indicators do not provide a good guide to the appropriateness of treatment, since, in most epidemiological settings, the proportion of fever cases that have evidence of malaria parasite prevalence is low (less than 30 percent) [25]. Accordingly, those indicators are no longer recommended.

Details on the strengths and limitations of all recommended case management indicators are listed in Table 7.

Table 7: Strengths and Limitations of All Diagnostic Testing and Treatment Indicators

Strengths	▪ The limited number of questions required to ascertain data for these indicators can be easily added to any nationally representative sample survey of households. ▪ Comparability is across countries, given that appropriate and consistent sampling procedures are followed and confounding factors are accounted for.
Limitations	▪ Data may not be based on reliable estimates of episodes of fever in previous two weeks. ▪ Fever may not have been the result of malaria infection. ▪ Data based solely on the mother's or caregiver's information may miss fostered children or others living in a household without a parent/caregiver. ▪ Data based solely on the mother's or caregiver's information may not be reliable if she or he did not take the child for care.

11. Proportion of Children under Five Years Old with Fever in Last Two Weeks Who Had a Finger or Heel Stick

- **Numerator:** Number of children under five years old with fever in the previous two weeks who had a finger/heel stick
- **Denominator:** Total number of children under five years old who had a fever in the previous two weeks

Purpose/Rationale

This indicator measures the extent to which children with fever obtain a parasitological diagnosis. Only a minority of fever cases that present to a health facility have evidence of malaria parasitemia when tested [25] and should be treated with antimalarial medicines. The majority of fever cases test negative and should not be treated with antimalarial medicines because (i) the true cause of fever should be ascertained and treated appropriately, (ii) treatment of patients with negative test results causes wastage of high-cost, artemisinin-based medicines, and (iii) treatment patients with negative test results causes increased selective pressure for drug resistance, thereby accelerating the onset of drug resistance.

Method of Measurement

The data for the denominator include children under five who had a fever in the previous two weeks. These data are obtained in one of two ways, depending on the type of survey. Some surveys use the household listing procedure, whereby every child under five who stayed in the house the previous night is identified (MICS). DHS and MIS surveys ask questions in the women's questionnaire about all of their biological children under the age of five; thus, the denominator excludes non-biological children. The numerator is then obtained by asking all mothers or caregivers in the household whether any of the children who had a fever in the past two weeks received a finger/heel stick.

Considerations

A finger/heel stick may not have been conducted to diagnose malaria (for instance, these methods are also used to diagnose anemia). However, the most likely purpose for this age group is malaria testing, especially when the child has a fever, so this should not be of considerable concern. The mother is not specifically asked whether the finger/heel stick was conducted for malaria testing due to concerns that an underestimate would result, as some women may not know whether the sample drawn was used for malaria diagnosis.

Interpretation

This indicator provides a proxy measure of the level of access of children under five years old to diagnostic testing for malaria infection. As countries scale up towards universal diagnostic testing, the indicator values reported are expected to increase but are unlikely to reach 100 percent because some fever cases will not seek care at places where tests are available, if at all. Most testing is done in public sector health facilities and the value of the indicator will depend partly on the proportion of fever cases that attend such facilities.

12. Proportion of Children under Five Years Old with Fever in the Last Two Weeks for Whom Advice or Treatment Was Sought

- **Numerator:** Number of children under five years old who had a fever in the previous two weeks for whom advice or treatment was sought
- **Denominator:** Total number of children under five years old who had a fever in the previous two weeks

Purpose/Rationale

This indicator captures national-level care seeking behavior for the treatment of malaria among children under five years old.

Method of Measurement

The data for the denominator include children under five that had a fever in the previous two weeks. These data are obtained in one of two ways, depending on the type of survey. Some surveys use the household listing procedure, whereby every child under five who stayed in the house the previous night is identified (MICS). DHS and MIS surveys ask questions in the women's questionnaire about all of their biological children under the age of five; thus, the denominator excludes non-biological children. The numerator is then obtained by asking all mothers or caregivers in the household whether treatment was sought for any of the children under five years old with fever in the last two weeks from any source.

Considerations

The mother of a child does not always know the exact qualifications of or the type of provider and, thus, may not be able to tell the interviewer this information.

Interpretation

Although *type of provider* is not a component of the indicator definition, program managers may find it useful to disaggregate this indicator by type of provider to determine whether treatment was sought by an appropriate provider.

This indicator does not determine why advice or treatment was not sought for some children.

13. Proportion Receiving an ACT (or Other Appropriate Treatment), among Children under Five Years Old with Fever in the Last Two Weeks Who Received Any Antimalarial Drugs

- **Numerator:** Number of children under five years old who had a fever in the previous two weeks who received an ACT (or other appropriate treatment according to national policy)
- **Denominator:** Total number of children under five years old who had a fever in the previous two weeks who received any antimalarial drugs

Purpose/Rationale

This indicator assesses what proportion of antimalarial treatment received by children under five are in accordance with national malaria treatment policy. Understanding which antimalarial drugs are provided is an important component for monitoring access to effective treatment.

Method of Measurement

The data for the denominator include children under five who had a fever in the previous two weeks. These data are obtained in one of two ways, depending on the type of survey. Some surveys use the household listing procedure, whereby every child under five who stayed in the house the previous night is identified (MICS). DHS and MIS surveys ask questions in the women's questionnaire about all of their biological children under the age of five; thus, the denominator excludes non-biological children. This is combined with information obtained by asking all mothers or caregivers in the household whether any of the children who had a fever in the past two weeks were given an antimalarial treatment. The numerator is then calculated by determining the number of these children who were provided with any ACT or other first-line treatments according to national policy in countries with non-*falciparum* malaria.

Considerations

This indicator is not limited to confirmed cases. Furthermore, it does not measure treatment in children under five with fever in the past two weeks for whom advice or treatment was not sought and those for whom advice or treatment was sought but who did not receive an antimalarial drug. Depending on the availability and use of parasitological confirmation, many of the children in the latter group may not have received antimalarial drugs due to the fact that their diagnostic test confirmed that their fever was not the result of malaria.

Additionally, there is no way of knowing if antimalarial treatments were administered correctly.

Interpretation

This indicator measures the extent to which ACT or other first-line treatments are used to treat malaria as a proportion of all antimalarial treatments and, thus, is a measure of effective treatment. Ideally, ACTs or other first-line treatments should represent almost all antimalarial treatments.

3.4 Impact Indicators

Data on anemia and parasitemia can be useful for assessing malaria morbidity. Parasite prevalence is malaria-specific and can provide a rough measure of transmission [26]. Additionally, anemia prevalence can reflect malaria morbidity and responds to changes in the coverage of malaria interventions [27, 28]. The standard MIS includes anemia and parasitemia biomarker measurements. The DHS also routinely collects anemia data from nationally representative samples and sometimes includes parasitemia measurements.

Monitoring trends in all-cause under five mortality rates using data from nationally-representative household surveys, such as DHS and MICS [29], is a useful exercise. However, this indicator can be influenced by several factors and does not provide specific information on malaria mortality trends.

In assessing whether malaria control programs have had an impact on all-cause mortality rates, it is possible to examine all-cause childhood mortality trends over a clearly defined time interval and, for the same time interval, observe changes in malaria intervention coverage, the prevalence of other factors influencing malaria and non-malaria childhood mortality (vaccination coverage, malnutrition, etc.) and morbidity indicators (anemia and parasite prevalence). If statistically significant reductions in mortality and morbidity are found *and* malaria intervention coverage has increased to high levels *and* other factors influencing all-cause childhood mortality have not changed substantially, then it is a plausible conclusion that malaria control activities caused or contributed to reductions in malaria-associated mortality. A more detailed description of this evaluation method has been described elsewhere [30].

Details on the strengths and limitations of all impact indicators are listed in Table 8.

Table 8: Strengths and Limitations of Impact Indicators

Strengths	▪ Representative of large populations of interest. ▪ Comparable across countries given that appropriate and consistent sampling procedures are followed.
Limitations	▪ Due to cost and other resource limitations, large nationally representative surveys are usually conducted on three-year or five-year cycles, and therefore, data may not be available at the optimal intervals for evaluation. ▪ The survey recall period may not coincide exactly with the scale-up period of interventions, causing their impact to be underestimated. ▪ Prevalence estimates for anemia and malaria parasitemia may be biased by the seasonality of survey data collection, since survey fieldwork for DHS and MICS is most often done during the dry season when prevalence is likely at its lowest.

14. Parasite Prevalence

Proportion of Children Aged 6-59 Months with Malaria Infection

(Obtained from household surveys rather than HMIS data)

- **Numerator:** Number of children aged 6-59 months with malaria infection detected by rapid diagnostic test or microscopy
- **Denominator:** Total number of children aged 6-59 months tested for malaria parasites by rapid diagnostic test or microscopy

Purpose/Rationale

The parasite prevalence among children aged 6-59 months is an indicator of malaria burden within populations and provides a guide to the level of malaria transmission.

Method of Measurement

Parasitemia testing should be included in surveys that are conducted during the high transmission season for malaria. In some cases where transmission is perennial (occurs all year), seasonal peaks may still influence the parasite prevalence and seasonality should be taken into account when planning a survey. The MIS should ideally be conducted when rains become intermittent and in the four to six weeks after the rains end. This timeframe is associated with peak transmission and is therefore suitable for measuring parasite prevalence. Large-scale household surveys are typically not suitable for inclusion of parasitemia measurement because these surveys are not usually conducted during the high transmission season and because of the length of fieldwork, which would cover different periods of seasonal transmission.

Parasitemia testing should target children aged 6- 59 months. This is the same age range that is targeted for anemia testing in both DHS and MIS surveys. Depending on a number of conditions in the survey setting, parasite prevalence should be based on either a high quality rapid diagnostic test (RDT) or microscopy. More detail on the appropriate use of each of these tests is given below.

Rapid Diagnostic Tests

Parasite prevalence should be based on the results of a high quality RDT in settings where there is reasonable evidence (from household surveys, routine data or special studies) that both of the following conditions prevail:

- *P. falciparum* accounts for nearly all infections (≥ 90 percent)
- Low level infections (<200 parasites/µl) are uncommon

The results of the WHO RDT Evaluation Program should be consulted when selecting an RDT {31]. At the time of publication of this manual, the latest results were available at:
http://www.who.int/malaria/publications/atoz/9789241502566/en/index.html

Microscopy

Prevalence should be based on microscopically examined blood films prepared in the field and read in a quality-controlled laboratory by well-trained microscopists in settings where there is reasonable evidence (from household surveys, routine data or special studies) that either of the following conditions prevail:

- Non-*falciparum* malaria or mixed infections account for more than 10 percent of infections
- Parasite density is expected to be below 200 parasites/µl in a substantial proportion of cases

In settings where the determination of species is necessary, thick blood films should be used to determine parasite prevalence and thin films should be examined to estimate levels of infection with *P. falciparum, P. vivax* or other species. Rapid diagnostic testing with tests that can detect all species present should also be included for field surveys so that all respondents with malaria can be treated or referred, according to national policy. Where both RDTs and microscopy are used for parasitemia testing, results of both should be reported.

It is important to recognize the distinction between diagnosis in clinical settings and identification of infected individuals for prevalence studies. Microscopy presents special issues for survey efforts. Field teams must be adequately trained to collect specimens on slides. The storage and transportation of slides is also difficult in the field and requires logistical planning. Supervision of these efforts is also important.

Considerations

Some studies of malaria interventions showing mortality reductions have found large decreases in parasite prevalence [32, 33]; however, other studies of control interventions have found that despite reductions in mortality, parasite prevalence changes little [8].

As measurement of parasite prevalence requires finger stick blood, some caretakers may not consent to parasitemia testing of their child. Additionally, survey personnel will require extra training to use RDTs or to collect blood on slides for microscopy.

Parasite prevalence can fluctuate dramatically throughout the course of a year with the seasonality of malaria, and thus values of the indicator may be influenced by the timing of a survey in relation to peak transmission. Accordingly, parasite prevalence should not be used for tracking the short-term impact of scaling up prevention efforts, as the prevalence rates may merely reflect differences in the timing of surveys in relation to within year variation in parasite prevalence. Parasite prevalence is better suited to measuring changes in malaria burden of over a longer term during which changes in parasite prevalence are expected to be much greater and outweigh within-year variation. To demonstrate a reliable trend, no more than four data points within a ten-year span are generally needed.

Interpretation

This indicator provides a direct measure of parasite prevalence among children aged 6-59 months at the national level.

Parasite prevalence is difficult to interpret and can fluctuate dramatically throughout the course of a year and is therefore not suitable for the detection of program impact over short periods of time.

When interpreting this indicator, the method of measuring parasite prevalence should be considered (microscopy vs. RDT). Microscopy detects parasites present in the blood at the time of the survey and therefore provides point *parasite prevalence*. By contrast, HRP2-based RDTs detect antigens to malaria parasites, which may endure for some weeks after treatment. This is especially important when interpreting trends over time, as parasite prevalence before the advent of RDTs was measured primarily using microscopy.

Table 9: Strengths and Limitations of Using RDTs and Microscopy for Population-based Surveys

	Strengths	Limitations
Rapid Diagnostic Tests	▪ Use requires less training than microscopy as it does not require staining, mounting and reading of slides. ▪ Results are rapid (within 15 minutes), thus facilitating timely treatment of infected individuals. ▪ In survey settings, costs are lower than those of microscopy (materials, transport and labor). ▪ Currently available RDTs have sensitivity and specificity comparable to routine microscopy.	▪ Some children previously treated for malaria may test positive by RDT within 14 days after treatment, as antigens often persist after treatment. ▪ Variation may exist between brands and types of RDTs (which antigens are detected). Across time and countries, this could affect the comparability of survey results. ▪ Limited determination of species (some tests detect only one Plasmodium species, usually *P. falciparum*, others detect any species but do not identify which is present). ▪ Quantification of parasites is not possible. ▪ Sensitivity is low for low parasite densities.
Microscopy	▪ Historically, considered the gold standard for malaria diagnosis. ▪ Permits determination of species and quantification of parasites. ▪ Can detect low density parasite infections. ▪ Historical comparisons possible assuming comparable skill of microscopists due to consistency of diagnostic methods over time. ▪ Slides can be stored and reexamined.	▪ There are practical difficulties preparing blood films in the field. ▪ Slides must be transported and stored. ▪ Sufficiently trained microscopists (especially in settings where determination of species is required) are not always available and there are often inconsistencies in reading slides. ▪ Variation is likely to occur between microscopists. ▪ Increases costs of survey. ▪ Sensitivity is low for low parasite densities. ▪ Increases time necessary before data become available.

Parasite Prevalence among All Ages

It is not recommended that parasite prevalence be estimated for all ages on a regular basis. However, in some cases the inclusion of all ages for testing may be warranted. These include special studies in settings where there is not a clear age pattern of malaria infection, surveys that will provide for modeling of incidence of malaria or surveys carried out where prevalence is very low or unstable.

Recruitment and testing of an older, less accessible population through large-scale household surveys face a number of challenges to gather estimates of parasite prevalence among all ages. These include:

Practical Challenges

- The time and cost associated with conducting a survey will increase significantly if parasite testing is extended to all age groups. When testing is conducted for children under five only, approximately 15 percent of the total sample population is tested. In contrast, up to 100 percent of that population will be tested to get an estimate for all age groups.

- School children and adults who work outside of the home are generally not present at home during the time of day that survey fieldwork is often conducted, and those who are home are more likely to be sick. In order to reduce the bias caused by this absentia, survey teams can carry out fieldwork during school holidays or late in the afternoon or they can conduct repeat visits to households during times when school children and working adults are more likely to be at home.

- Evidence from surveys that tested all age groups in Djibouti and Sudan showed that a substantial proportion of adults will refuse testing [34, 35].

Epidemiological Challenges

- During pregnancy, malaria parasites can sequester themselves in the placenta. Routine light microscopy and RDTs cannot detect all infections in peripheral blood, which serves as the sample for parasite testing in MIS [36-38].

- In most low risk countries where national prevalence is two percent or less, it is probable that all age parasite prevalence estimates will be imprecise, especially sub-nationally.

Case Management Challenges

There are difficulties related to testing and treating pregnant women, especially early pregnancies which are more difficult to detect, since treatment protocols are different for pregnant and non-pregnant women.

- First, survey implementers must establish whether a woman is pregnant to be able to provide the correct treatment. Since household surveys do not conduct pregnancy tests, pregnancy status would have to be based on women's reports on whether or not they are pregnant. Self-reported pregnancy status is considered unreliable because many women either do not know they are pregnant or do not want to divulge this information during early pregnancy. There also may be some bias if any reluctance to discuss pregnancy is associated with first births, adolescence and other demographic factors.

- If it is established that a woman who tests positive for malaria is pregnant, the trimester of her pregnancy must be determined in order to follow appropriate treatment protocol. In past surveys in some countries, it was required that a qualified nurse or equivalent be present in the survey team to conduct a pregnancy history and determine the trimester so that appropriate treatment could be provided [34, 35].

- In some settings, the first-line treatment for malaria is also used for malaria during pregnancy. However, in many settings national treatment guidelines depend on the trimester of pregnancy. This may require that the survey implementers procure more than one type of antimalarial drug in order to treat pregnant women.

- Some recommended treatments are given over a period of days and thus cannot be administered by survey personnel. Individuals can be referred to nearby health centers for treatment; however, some health centers may be very distant from survey households and/or may not have the appropriate antimalarial drugs.

In sum, one should proceed cautiously when considering extending this indicator to respondents of all ages, but under some circumstances special studies may be deemed appropriate and an additional indicator should then be calculated.

15. Anemia Prevalence

Proportion of Children Aged 6-59 Months with a Hemoglobin Measurement of <8 g/dL

- **Numerator:** Number of children aged 6-59 months with a hemoglobin measurement of <8 g/dL
- **Denominator:** Total number of children aged 6-59 months who had hemoglobin measurements obtained during household survey

Purpose/Rationale

Anemia, defined by a hemoglobin (Hb) concentration below established cut-off levels, is a widespread public health problem. Although anemia is not specific to malaria, it can be useful to follow trends in anemia prevalence, as they can reflect the impact of malaria interventions [27, 28]. Malaria interventions have been associated with a 60 percent reduction in the risk of moderate-to-severe anemia (Hb<8.0 g/dL) [27].

Method of Measurement

Monitoring anemia through household surveys has become a more viable option due to the development of the HemoCue® test of finger stick blood, which is used to measure Hb distributions in large-scale household surveys. Anemia should be measured in children 6-59 months old. Surveys should record Hb measurements to the 0.1 g/dL precision level using a HemoCue® instrument on capillary blood sampled while the child is sitting [28].

An Hb concentration cut-off of less than 7.0 g/dL has been widely used to classify severe nutritional anemia [40, 41] but a different cut-off, 8.0 g/dL, is used to classify malaria-related anemia, as intervention trials have shown that malaria control reduces the prevalence of moderate-to-severe anemia (below 8.0 g/dL) more so than it reduces the prevalence of any anemia (below 11.0 g/dL) [27].

Data on altitude should be used to adjust anemia prevalence estimates in countries that have any enumeration areas above 1,000 meters, as normal hemoglobin distributions vary with altitude. In order to supply a sufficient amount of oxygen to the tissues, individuals living at higher altitudes must produce more red blood cells to compensate for lower oxygen partial pressure and decreased oxygen saturation of blood. The recommended adjustment factors, described by the Centers for Disease Control and Prevention, are available at: http://www.cdc.gov/mmwr/pdf/rr/rr4703.pdf [42]. When altitude data are not used to adjust results in areas of high altitude, underestimates of anemia are likely to occur.

Considerations

A potential drawback to this indicator is the seasonal variation in malaria-related anemia, which makes survey outcomes sensitive to the season of measurement.

As measurement of anemia requires finger stick blood, some caretakers may not consent to anemia testing of their child. Additionally, survey personnel will require extra training to carry out HemoCue® testing.

Interpretation

This indicator provides a proxy measure of the prevalence of malaria-related anemia among children aged 6-59 months at the national level.

Anemia measurement has become a standard component of DHS and some other household surveys. However, it should be noted that DHS surveys include anemia measurements in the nutrition chapter, using the cut-off value of less than 7.0 g/dL rather than 8.0 g/dL, necessitating that caution be taken when interpreting and comparing results.

Use of anemia as a malaria indicator will be compromised by a lack of specificity, particularly in areas with low malaria transmission, given other anemia determinants such as pediatric HIV/AIDS, malnutrition and helminth infections. Even in areas of intense malaria transmission, moderate to severe anemia in young children may depend more on undernutrition than on malaria, and separating malnutrition from malaria as the cause of anemia is not possible, as the proportions will vary from population to population and cannot be known. Consequently, data must be interpreted cautiously, with consideration of the many other causes of anemia present in the survey area.

Additional analysis

Survey reports should tabulate both the prevalence of Hb <8.0 g/dL and the mean hemoglobin level, preferably with its standard deviation so that the user can derive anemia prevalences with alternative cut-offs by applying a normal approximation [28]. In survey reports which include sections on both nutrition and malaria, the prevalence of Hb <7.0 g/dL and the prevalence of Hb <8.0 g/dL should be reported in the appropriate chapters. Consequently, analyses using both Hb cut-offs will need to be conducted. Furthermore, it should be clearly stated in the text that the first is measuring severe anemia in order to assess nutritional deficiencies, while the second is measuring moderate-to-severe anemia in order to assess the impact of interventions on malaria-related anemia.

16. All-Cause Under-Five Mortality Rate

Purpose/Rationale

In areas of stable endemicity, the major burden of malaria occurs in very young children who, because they have not yet developed adequate clinical immunity, are at the highest risk of severe illness and death; globally, malaria accounts for approximately seven percent of all child deaths [2]. Thus, in areas of stable transmission, malaria control interventions should have an impact on all-cause under five mortality trends.

Method of Measurement

The under-five mortality rate (U5MR) can be derived from household survey data using direct or indirect methods. The direct method is used in DHS surveys and requires a birth history that includes information on all children ever born, their survival status and (for non-surviving children) their age at death, in order to calculate the probability of dying before age five from children exposed to mortality during the five-year period before the survey. More specifically, the DHS employs the synthetic cohort life table approach, in which mortality probabilities for small age segments based on real cohort mortality experience are combined into larger age segments that correspond to the age group of interest.

In the majority of MICS surveys, U5MR are calculated based on an indirect estimation technique known as the Brass method. This technique converts the proportion of children who have died among women in a certain age group into the probability of dying by an exact childhood age. By using model life tables and strong assumptions as to age patterns and time trends, the mortality rate estimates are indirectly derived, as well as the date to which they apply. However, some MICS surveys use birth histories to calculate direct estimates of U5MR.

The MIS was conceptualized to provide national-level estimates of malaria infection. As MIS surveys are topic specific and as most of the malaria indicators of interest do not require a large sample size to measure reliably, these surveys are typically much smaller in scale than DHS or MICS. MIS surveys are not designed to collect estimates of child mortality. Standard MIS questionnaires do not include the questions necessary for calculating mortality rates. Birth history information is collected for children born in the six years immediately preceding the survey for the main purpose of defining denominators for other indicators. In countries which lack reliable vital registration systems, accurate estimates of child mortality rates are best obtained through DHS or MICS surveys.

Considerations

U5MR has the benefit of capturing both direct and indirect effects of malaria interventions on under-five mortality, i.e., the effects on malaria mortality and on mortality from other causes that are influenced by malaria. Changes in U5MR may, however, be influenced by a variety of factors other than malaria control.

The indicator can be measured reliably and does not suffer from limitations of methods to identify malaria-specific deaths. However, underenumeration of deaths is always a possibility in household surveys.

Household surveys calculate mortality rates over a five-year period to make sure there are enough cases to produce reliable results. Therefore, on average, surveys measure under-five mortality with a 2.5 year lag. Additionally, point estimates of U5MR will be centered at a different time to indicators of intervention coverage estimated from the same survey.

In areas of moderate to high malaria transmission, malaria may account for as much as 30% of under 5 mortality due to all causes. In these settings, if malaria-specific mortality decreases by 50 percent, a 15-19 percent reduction in all-cause under-five mortality is generally expected. At the usual sample size, DHS surveys have the statistical power to confirm under-five mortality reductions between two successive surveys if the true mortality reduction is 15 percent or larger. Consequently, the ability to detect a reduction in all-cause mortality resulting from fairly small reductions in malaria deaths may be difficult when relying on this data source.

Estimation methods currently do not account for selection bias that may arise due to high HIV prevalence.

Interpretation

This indicator provides a measure of all-cause under-five mortality at the national level.

Malaria-Specific Mortality

In some cases, verbal autopsies (VA) nested within household surveys may provide information on malaria-specific mortality at the national level. VA is the process of interviewing the primary caregivers of recently deceased persons to gather information on the circumstances surrounding death. It requires that the primary caregiver of the deceased – usually a family member – can recall and recognize symptoms/signs experienced by the deceased in the period leading up to death. This information is then interpreted by physicians to derive a probable cause of death. VA can be performed either as part of a mortality survey or by sending interviewers after the survey to those households in which eligible deaths were identified. This survey-nested approach could provide estimates of malaria-attributable mortality at the national level. However, due to the low sensitivity and specificity of the tool in detecting malaria-specific mortality, further research is needed to assess and improve these methodologies.

Other potential sources, such as vital registration systems and HMIS, should also be explored.

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Annex 1: Previously Recommended Indicators

The following indicators were previously recommended by the RBM MERG but are no longer recommended.

H1. Proportion of Children under Five Years Old with Fever in the Last Two Weeks Who Received Any Antimalarial Treatment

- **Numerator:** Number of children under five years old who had a fever in the previous two weeks who received any antimalarial treatment
- **Denominator:** Total number of children under five years old who had a fever in the previous two weeks

H2. Proportion of Children under 5 Years Old with Fever in Last 2 Weeks Who Received Antimalarial Treatment according to National Policy within 24 Hrs from Onset of Fever

- **Numerator:** Number of children under five years old who had a fever in the previous two weeks who received recommended antimalarial treatment according to national policy within 24 hours from onset of fever
- **Denominator:** Total number of children under five years old who had a fever in the previous two weeks

Purpose/Rationale

The intention of the indicators was to capture the utilization of antimalarial treatment to children under five years old with fever. The indicators have become problematic as diagnostic testing has scaled up; they do not take into account the fact that some febrile children will be given a diagnostic test and those that test negative should not be given an antimalarial medicine. As a result, countries or areas with more accessible health services and diagnostic testing can produce lower values of the indicator than those with weaker health services. In addition, for those children that are not tested, the indicators do not provide a good guide to the appropriateness of treatment since in most epidemiological settings the proportion of fever cases that have evidence of malaria parasitemia is low (less than 30 percent) [26].

Annex 2: Sample Stata® Code for Calculating Intermediate Variable for Indicator 3 – Proportion of Population with Access to an ITN within Their Household

The calculation of Indicator 3 – *Proportion of Population with Access to an ITN within Their Household* (page 20) needs an intermediate variable which is "potential users." It can be calculated by multiplying the number of ITNs in each household by two. The product of this calculation may be greater than the number of individuals who spent the previous night in a household if a household has more than one ITN for every two people. In this case, the "potential users" variable in that household should be modified to reflect the number of individuals who spent the previous night in the household, because the number of potential users in a household cannot exceed the individuals who spent the previous night in that household.

The indicator can then be calculated by dividing the sum of all potential ITN users in the sample by the total number of individuals who spent the previous night in surveyed households. An example of the Stata® code used to calculate this indicator is provided below.

Sample Stata®, Version 12 Code

```
* create access variable in individuals file (household roster)

* variable " numitnhh " is the number of ITN per household from the household file
* variable "sleep" is the de-facto residency (slept in the household the night before) yes=1, no=0
* variable "hhid" is the unique identifyier for the household

gen potuse= numitnhh *2
label var potuse "potential ITN users in hh"
bysort hhid: gen access=potuse/sleep>1
svy: mean access if sleep==1
```