

MODULE 1:

OVERVIEW OF MALARIA

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This module provides an introduction to the basics of malaria, including what malaria is and how it is transmitted, an introduction to the epidemiology and burden of malaria, an overview of the global efforts to control malaria, and a description of the main interventions for malaria control and prevention.

Module Objectives

By the end of this module, you will be able to:

- Describe malaria and how it is transmitted
- State how malaria transmission is associated with climate
- Describe the general epidemiology of malaria
- Describe the global burden of malaria
- Describe the global efforts to control and eliminate malaria
- Describe the different types of malaria interventions

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Malaria Basics

Malaria is a parasitic infection that is transmitted to humans by the bite of female Anopheles mosquitoes.

There are five parasite species that transmit malaria infection to humans: *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium malariae*, and *Plasmodium knowlesi*. *P. falciparum* and *P. vivax* are the most common species, and *P. falciparum* is the most deadly of the five. P. *falciparum* causes 99.7 percent of estimated malaria cases in sub-Saharan Africa, 62.8 percent in Southeast Asia, 69 percent in the Mediterranean, and 71.9 percent in the Pacific region. P. *vivax* represents 74 percent of malaria cases in South America (World Malaria Report 2018).

Mosquitoes mainly feed and rest indoors; the peak biting time is in the late evening. They breed in shallow collections of fresh water, such as puddles.

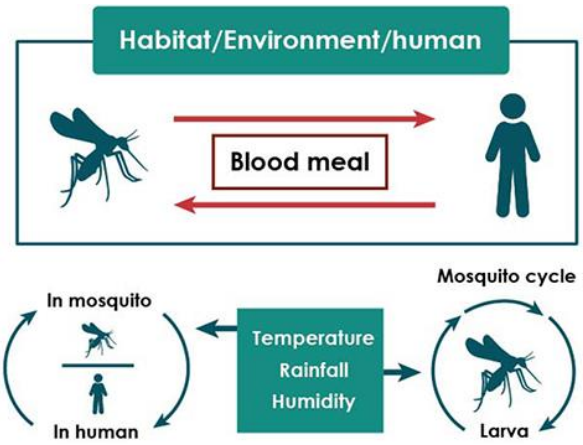
Everyone is susceptible to malaria infection; however, pregnant women and children under five bear the greatest burden of malaria. Young children under the age of five are vulnerable because they have not yet developed protective immunity against the most severe forms of the disease. Pregnant women and their newborns also are vulnerable because malaria infection can increase the risk of miscarriage and low birth weight, as well as maternal and newborn death.

Malaria Transmission

People are infected with malaria after they are bitten by a female Anopheles mosquito that is infected with one of the plasmodium parasites. The parasite enters the human blood stream and goes to the liver. In the liver, the parasite matures and replicates before being released back into the bloodstream. This is referred to as the incubation period, during which the person does not experience any symptoms. The onset of symptoms typically occurs 9 to 30 days after a person has been bitten by an infected mosquito.

There are many factors related to the vector, parasite, human host, and conditions within the environment that influence the transmission of malaria. For example, transmission is highly dependent upon the climatic conditions, such as the amount and pattern of rainfall in an area, temperature, and humidity.

Figure 1. Malaria transmission cycle



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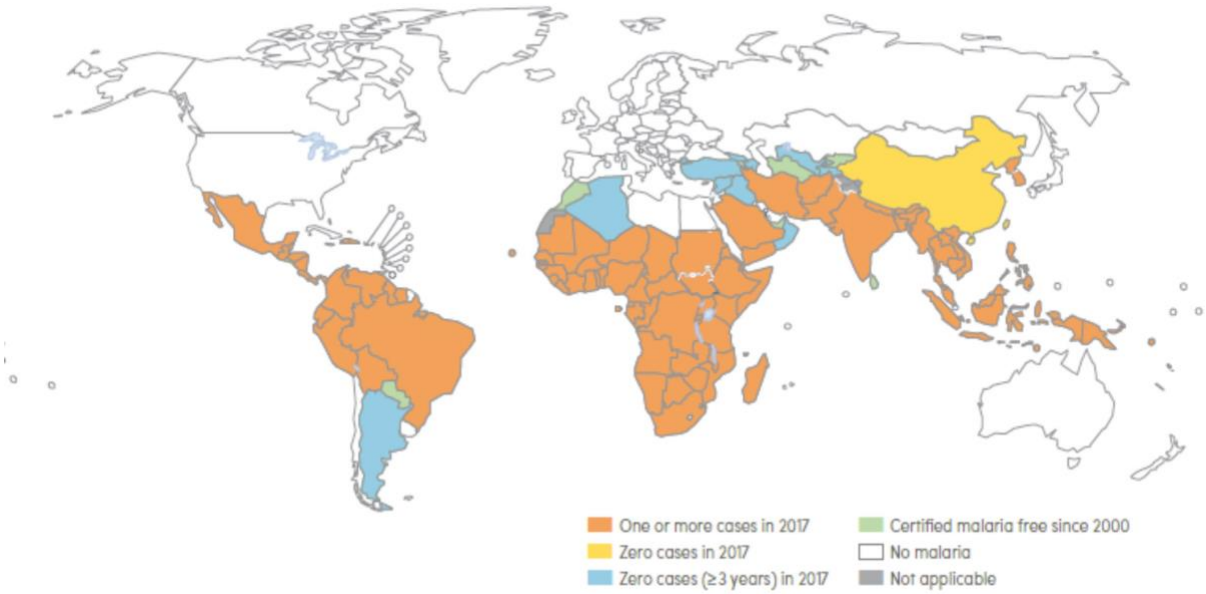
In many places, transmission is seasonal, meaning that it only occurs or occurs more frequently during certain times of the year and not necessarily year-round. Often there is a peak of malaria transmission during and right after the rainy season. Transmission can also vary within a country, with certain areas affected year-round, seasonally, or not at all. Lastly, transmission can vary from year to year within a location. Thus, tracking transmission is very complex and requires information regarding many of the factors described above, including rainfall, temperature, and humidity, among others. Altitude is another factor that influences transmission. At higher altitudes, malaria transmission will not occur.

Where Malaria Is Prevalent

Malaria is prevalent in tropical and subtropical climates and is found throughout Central and South America, sub-Saharan Africa, the Eastern Mediterranean, and Asia. Currently, 87 countries are malaria endemic with ongoing transmission. Of these, 10 are currently on track to meet their objectives for elimination by 2018.

Figure 2. Malaria in the world

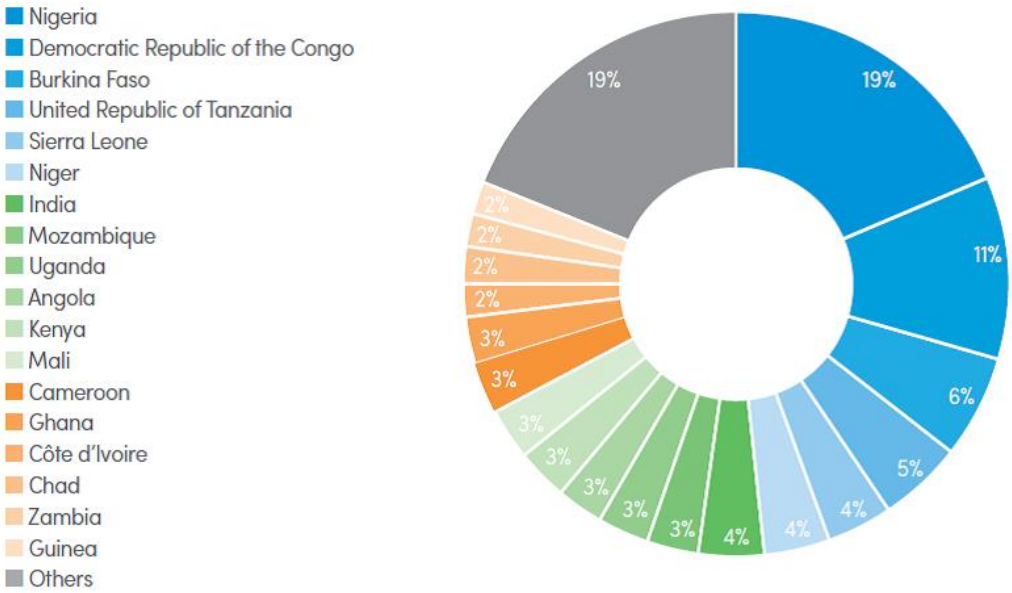


Source: World Malaria Report, 2018

Burden of Malaria

Half of the world's population (3.2 billion people) is at risk of malaria. In 2017, there were about 219 million malaria cases worldwide and nearly 435,000 deaths due to malaria. Fifteen countries, all in sub-Saharan Africa except India, carry 80 percent of the global malaria burden.

Figure 3. Percentage of estimated malaria deaths by country, 2018



Source: World Malaria Report, 2018

Most of the malaria burden is found in sub-Saharan Africa, accounting for an estimated 92 percent of malaria cases and 93 percent of deaths worldwide. It is estimated that 74 percent of the population lives in areas that are highly endemic, and 19 percent of the population lives in epidemic-prone areas.

The economic costs of malaria are tremendous. It is estimated that malaria causes a 1.3 percent loss in gross domestic product growth per year for Africa. It also results in a total of US$12 billion in direct losses per year. Around 40 percent of public health spending in Africa is for malaria. The average household spends greater than 10 percent of its yearly income on malaria prevention and treatment. The global technical strategy for malaria estimates that $6.5 billion is needed per year to achieve global malaria control and elimination goals; however, major gaps in funding make it impossible to reach global targets. In 2016, only $2.7 billion in global contributions were received, leaving a $3.8 billion shortfall.

Due to the large scale-up of malaria prevention and control interventions over the past 17 years, and particularly within the past 10 years, the malaria burden has decreased overall worldwide. In 2017, an estimated 219 million cases of malaria occurred worldwide, compared to 237 million cases in 2010, suggesting a reduction of 18 million cases. The estimated malaria incidence rate has decreased globally by 17 percent, from 76 cases per 1,000 population at risk in 2010 to 59 cases per 1,000 population at risk in 2017. The World Health Organization (WHO) South-East Asia Region recorded the largest decrease (59%), but in the WHO America region, the incidence increased due to malaria transmission in Brazil, Nicaragua, and Venezuela. The WHO Africa Region remains at 219 cases per 1000 population at risk since 2016. Between 2000 and 2016, mortality rates from malaria have decreased significantly.

Efforts to Control Malaria

To understand the efforts to control malaria today, it is important to recognize the history of the disease and previous efforts to control and eradicate it.

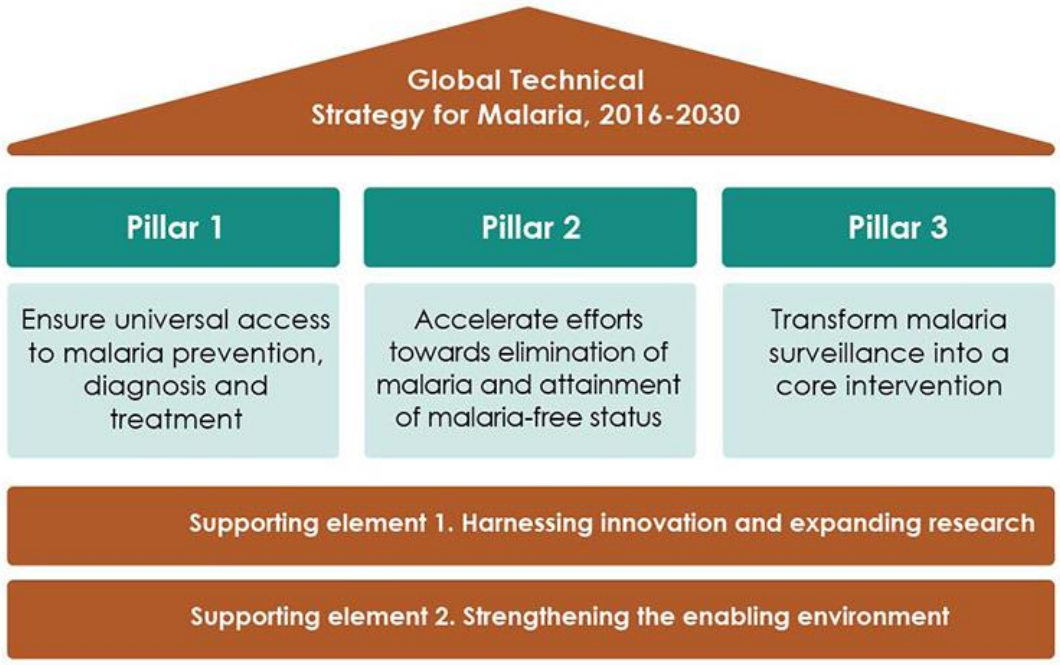
In 1955, WHO launched the Global Malaria Eradication Campaign. The campaign was successful in eliminating malaria from a number of countries but failed to achieve its ultimate goal of global eradication. Within less than two decades, however, it was recognized that a time-limited eradication program was not practical for all countries, and the focus of the program shifted from eradication to malaria control.

During the 1970s and 1980s, malaria received very little attention. It reemerged as a major international health issue again in the 1990s. With new attention and focus on malaria control, a global malaria control strategy was adopted in 1992. The Roll Back Malaria Partnership, created in 1998, is the global framework for implementing coordinated action against malaria.

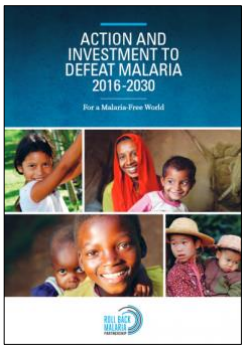
In 2000, the Abuja Declaration was signed by 44 malaria-afflicted countries in Africa, declaring their commitment to the effort to halve malaria mortality in Africa by 2010. The Millennium Development Goals (MDGs) were also created that year, with MDG 6 reflecting the increased efforts toward malaria control. MDG 6 resulted in a decrease of malaria incidence by 37 percent globally and malaria deaths by 60 percent. However, serious bottlenecks remain providing full access to malaria prevention, diagnostic testing, and treatment mainly in sub-Saharan Africa. To build on the success of the MDGs, world leaders adopted 17 Sustainable Development Goals (SDGs) in 2015. Goal 3.1 and 3.2 focus on reducing global maternal and child mortality respectively.

In addition, WHO's Global Technical Strategy for Malaria, 2016–2030 provides a comprehensive framework for countries to develop their programs to accelerate toward malaria elimination. The strategy focuses on the three pillars below:

Figure 4. The three pillars of WHO's global malaria strategy



In alignment with these pillars, RBM developed an operational document with milestones and targets, called RBM's Action and Investment to Defeat Malaria 2016-2030 (AIM). All these initiatives are responsible for the increased efforts and funding for malaria control and prevention over the last 15 years, which have included USAID/PMI, the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund), the Bill & Melinda Gates Foundation, and the World Bank.



Malaria Prevention and Control Interventions

Malaria prevention and control efforts focus primarily on reducing human contact with mosquitoes, reducing the overall reservoir of infected people, and reducing the mosquito population through vector control mechanisms.

The most effective strategies used worldwide are vector control, chemoprevention, case management and malaria surveillance. Vector control prevents mosquitos from acquiring or passing on an infection through the use of insecticide-treated nets (ITNs) or long-lasting insecticidal nets (LLINs) and the indoor residual spraying (IRS) of households. Chemoprevention suppresses and prevents infections in humans through intermittent preventative treatment for pregnant women (IPTp) and seasonal malaria chemoprevention (SMC). Case management detects, diagnosis, treats, and cures infections using safe and quick diagnostic testing and effective and timely treatment. Malaria surveillance detects and investigates all malaria infections to prevent secondary infections. Because each country's malaria context is unique, its combination and focus of interventions will vary based on what is most appropriate for its particular context.

Insecticide-Treated Nets

ITNs and LLINs reduce human contact with mosquitoes by providing a protective shield between the mosquito and the human host during the evening, when mosquitoes typically feed. ITNs, when used appropriately and consistently, reduce all-cause mortality by 17 percent and malaria cases by 50 percent at full coverage. The main difference between ITNs and LLINs is that LLINs maintain effective levels of insecticide for at least three years, whereas ITNs typically are effective for 12 months.

Indoor Residual Spraying

IRS involves spraying the inside of the house, including the walls and roofs, with insecticides to reduce human-mosquito contact. High coverage of IRS within a community provides increased protection for the entire community, including the households that were not sprayed.

Intermittent Preventive Treatment

IPTp entails administering an antimalarial drug (currently sulfadoxine-pyrimethamine) to women during their pregnancy to prevent and control malaria. It is recommended that IPTp be given to pregnant women during each scheduled routine antenatal care visit beginning in the second trimester, with doses given at least one month apart.

Seasonal Malaria Chemoprevention

The goal of SMC is to prevent malaria infection by maintaining therapeutic blood levels through malaria treatment during the period of peak transmission by giving sulfadoxine-pyrimethamine and amodiaquine

to children ages 3–59 months, every month up to a maximum of four doses. The distribution is primarily done by going door-to-door in most countries.

Case Management

Effective case management entails ensuring access to diagnostic testing and effective and timely treatment. Prompt parasitological confirmation, either by microscopy or rapid diagnostic tests (RDTs), is recommended in all patients with suspected malaria prior to starting treatment. Prompt and effective treatment entails receiving antimalarial treatment within the first 24 hours after the onset of symptoms of malaria. The best available treatment, particularly for *P. falciparum,* is artemisinin-based combination therapy (ACT).

Malaria Surveillance

Surveillance has been adopted as a full-fledged malaria intervention. It aims to detect all infections of malaria and investigate each case of infection to ensure that each case detected is treated quickly to prevent secondary infections. This makes it possible to track diseases and respond programmatically while making decisions based on the data collected.

Other Interventions

Malaria vaccines, such as the RTS,S vaccine, are currently being developed and tested in various countries. Mass drug administration (MDA), mass screening and treatment (MSAT), focal screening and treatment (FSAT), therapeutic efficacy surveillance (TES), sensitive polymerase chain reaction (PCR) testing, and larviciding are also under development.

Success Story: Zanzibar

The story of malaria in Zanzibar represents one of the greatest achievements to date in sub-Saharan Africa in the fight against malaria. For many years, malaria was Zanzibar's number one public health problem. Malaria in Zanzibar was characterized by perennial stable transmission, with seasonal peaks during and immediately after the rainy seasons. In 2003, malaria accounted for 52 percent of cases and 53 percent of deaths among all inpatients. Drug resistance was high, with treatment failure rates found to be around 60 percent.

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Over the past decade, the island of Zanzibar has experienced a rapid decrease in its malaria burden. Since 2010, malaria prevalence on the island has dropped from as high as 70 percent to its current rate of less than 1 percent. The accelerated decrease is attributable to the large scale-up of malaria control and prevention activities.

In 2003, the Zanzibar Ministry of Health and Social Welfare changed malaria treatment guidelines for uncomplicated malaria from chloroquine and sulfadoxine-pyrimethamine to the much more effective ACTs. In 2003, ACTs were made available free of charge in all public health facilities, greatly increasing access to malaria treatment. By 2007, RDTs were also made available in health facilities, further expanding coverage of diagnostic testing.

Zanzibar has also had widespread distribution of LLINs, and several rounds of IRS have been conducted. These efforts have resulted in a dramatic increase in coverage of ITNs and IRS, with the island successfully achieving universal access to ITNs. A strong surveillance, monitoring, and evaluation (SME) system, designed and implemented by the Zanzibar Malaria Elimination Programme, has further led to the successful control and reduction of malaria. The story of Zanzibar demonstrates that successful control and reduction of malaria burden is possible in Africa, when large-scale coverage of the main malaria control interventions is combined with effective political and donor support. Due to these efforts and successes, Zanzibar has shifted from a malaria control program to one that is now focused on elimination of malaria.

Changing Context

Progress is being made to reduce malaria burden through increased intervention coverage, surveillance, and understanding of local malaria transmission settings within countries. Improvement of the malaria SME system is key to achieving elimination. Yet there are still challenges stalling progress. Remaining challenges include:

- Emergence of parasite resistance to antimalarial medicines (artemisinin and partners) and mosquito resistance to insecticides
- Discovery of new type of exophilic mosquitos
- Poor health system performance
- Lack of sustainable and predictable international and domestic funding
- Disruptive service delivery due to natural factors (excessive rain or earthquakes) and political conflicts
- Climate change

Major progress has been made in existing interventions. New interventions have been added to the suite to help in malaria control. Yet, progress is stalling, not because interventions are ineffective, but because there is still not enough global funding going toward malaria control and elimination. Until the $3.8 billion gap is met, it will be difficult to move toward eliminating malaria.

Module 1 Assessment

Questions

Correct answers are provided on the next page.

1. Which species of malaria parasite are more prevalent in sub-Saharan Africa?

    a. *Plasmodium malariae*
    b. *Plasmodium falciparum*
    c. *Plasmodium vivax*
    d. *Plasmodium ovale*

2. Which groups are the most vulnerable to malaria infection? *(Select all that apply.)*

    a. Children under five years of age
    b. Men ages 18 years and older
    c. Women who are pregnant
    d. Children ages 5–18 years
    e. Women ages 15–49 years

3. Which of the following factors influences malaria transmission risk?

    a. Humidity
    b. Temperature
    c. Rainfall
    d. All of the above

4. In which region of the world is the burden of malaria the greatest?

    a. Southeast Asia
    b. Eastern Mediterranean
    c. Africa
    d. Latin American and the Caribbean

5. Which of the following is NOT one of the main malaria control and prevention strategies?

    a. Using insecticide-treated nets
    b. Administering antimalarial drugs to pregnant women who are at risk of malaria
    c. Spraying the outside of houses with insecticides
    d. Spraying the interior walls of houses with insecticides

6. Making up for the US$3.8 billion deficit in funding for malaria control interventions would help achieve malaria elimination.

    True or false

Correct Answers

Correct answers are noted in bold.

1. Which species of malaria parasite are more prevalent in sub-Saharan Africa?

   b. *Plasmodium falciparum*

   In sub-Saharan Africa, malaria is mainly caused by *Plasmodium falciparum*, although *P. ovale* and *P. malariae* are also present.

2. Which groups are the most vulnerable to malaria infection? *(Select all that apply.)*

   a. Children under five years of age
   c. Women who are pregnant

   Everyone is susceptible to malaria infection; however, pregnant women and children under five bear the greatest burden of malaria.

3. Which of the following factors influences malaria transmission risk?

   d. All of the above (humidity, temperature, and rainfall)

   Transmission is highly dependent upon the climatic conditions, such as the amount and pattern of rainfall in an area, temperature, and humidity.

4. In which region of the world is the burden of malaria the greatest?

   c. Africa

   The majority of the malaria burden is found in sub-Saharan Africa. It is estimated that 74 percent of people living in Africa live in areas that are highly endemic, and 19 percent of the population lives in epidemic-prone areas.

5. Which of the following is NOT one of the main malaria control and prevention strategies?

   c. Spraying the outside of houses with insecticides

   The primary methods for prevention include insecticide-treated nets or long-lasting insecticide treated nets, indoor residual spraying of households, intermittent preventative treatment for pregnant women, and prompt and effective treatment with antimalarial drugs.

6. Making up for the $3.8 billion deficit in funding for malaria control interventions would help achieve malaria elimination.

   True