LESSON 13

Vectored Infectious Diseases: Malaria in Ethiopia

| Aynalem Adugna, July 2014

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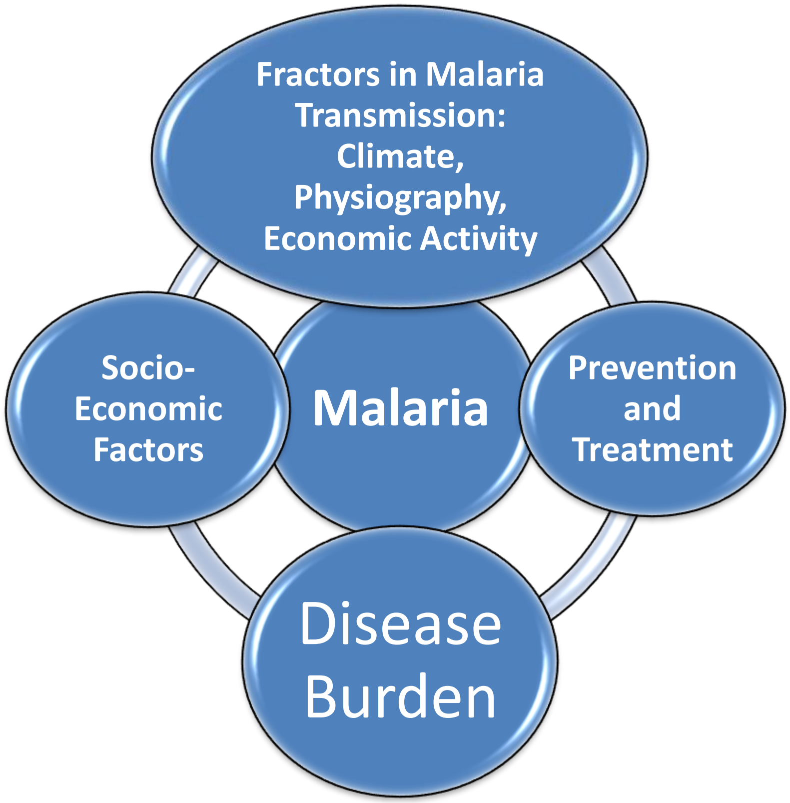


Malaria

Introduction

Ethiopia's fight against Malaria started more than half a century ago. "Initially malaria control began as pilot control project in the 1950's and then it was launched as a national eradication campaign in the 60's followed by a control strategy in the 70's". "In 1976 the vertical organization known as the National Organization for the Control of Malaria and Other Vector-borne Diseases (NOCMVD) evolved from the Malaria Eradication Service (MES)" [1]. The effort has seen alternating periods of successes and failures. As is the case in all places where malaria is endemic, the disease is far from being conquered. The agent – plasmodium – has developed resistance to a number of drugs and the vector mosquito has developed resistance to drug chemicals used to kill it. The early 21st century fight in Ethiopia was guided by the Abuja (Nigeria) declaration with the following targets for the year 2005 [2]:

- At least 60% of children affected by malaria should have access to rapid, adequate and affordable treatment,
- At least 60% of those at risk, especially pregnant women and children under five, should benefit from the most appropriate combinations of personal and communal protection, including insecticide treated nets (ITNs),

- At least 60% of pregnant women at risk, especially those at first pregnancy, should have access to intermittent preventive treatment.

It is estimated that three-fourths of the land below 2000 meters in Ethiopia is malarious with two-thirds of the country's population at risk. [2]. This makes malaria the number one health problem in Ethiopia with an average of 5 million cases a year [3] and 9.5 million cases each year between 2001-and 2005 [4]. The disease causes 70,000 deaths annually and accounted for 17% of outpatient visits. It also accounted for "…15% of admissions and 29% of inpatient deaths" - but these figures considered to be low given that more than a third of the country's population does not have access to health services and cases go unreported [4]. A number of contributing factors have been identified to explain the high incidence and prevalence rates of malaria in Ethiopia:

> The burden of malaria has been increasing due to a combination of large population movements, increasing large-scale epidemics, mixed infections of *Plasmodium vivax* and *P. falciparum*, increasing parasite resistance to malaria drugs, vector resistance to insecticides, low coverage of malaria prevention services, and general poverty. Outpatient consultations, inpatient admissions and all in-patient deaths have risen by 21-23% over the last five years. …Ethiopian adults, unlike their counterparts in more endemic areas, have relatively little protective immunity and are also *vulnerable* to malaria. …Epidemics, which traditionally occur every five to eight years, are a hallmark of malaria in Ethiopia. The epidemic of 1950 is estimated to have caused 3 million cases and resulted in 150,000 deaths. Unstable and largely unpredictable malaria epidemiology makes surveillance, information management and logistics for vector control and pharmaceuticals of paramount importance… *Plasmodium vivax* and *Plasmodium falciparum* comprise 40% and 60% of malaria infections respectively [4]

Malaria (on the negative side) and the timely arrival of rainfall (on the positive side) are among the most crucial determinants of economic performance in Ethiopia with GDP growth rising and falling in Ethiopia in the aftermath of a rise or fall in rainfall amounts and the severity of malaria transmissions. The Ministry of Health has summarized the impact of malaria in Ethiopia as follows:

> "The socioeconomic burden resulting from malaria is immense: 1) the high morbidity and mortality rate in the adult population significantly reduces production activities; 2) the prevalence of malaria in many productive parts of the country prevents the movement and settlement of people in resource-rich low-lying river valleys; on the flip side, the concentration of population in non-malaria risk highland areas has resulted in a massive environmental and ecological degradation and loss of productivity, exposing a large population of the country to repeated droughts, famine and overall abject poverty; 3) the increased school absenteeism during malaria epidemics significantly reduces learning capacity of students; 4) coping with malaria epidemics overwhelms the capacity of the health services in Ethiopia, and thus substantially increases public health expenditures." (cited in [3])

Malaria shows a strong seasonal pattern "…with a lag time varying from a few weeks at the beginning of the rainy season to more than a month at the end of the rainy season" [3].

Government actions and international assistance are helping to make a difference under the "roll back malaria" (RBM) banner. The current operational plan, also known as "the [US] President's Malaria Initiative (PMI)" is assisted by and seeks to build on the United States Government's

"… $1.2 billion initiative to rapidly scale up malaria prevention and treatment interventions in high-burden countries in sub-Saharan Africa". The goal of the US initiative is [4]:

> "… to reduce malaria-related mortality by 50% after three years of full implementation in each country. This will be achieved by reaching 85% coverage of the most vulnerable groups, children under five years of age, pregnant women, and people living with HIV/AIDS, incorporating proven preventive and therapeutic interventions, including artemisinin-based combination therapies (ACTs), insecticide-treated bed nets (ITNs), intermittent preventive treatment of pregnant women (IPTp), and indoor residual spraying (IRS).

The Ethiopian President's Initiative (PMI) has a regional focus with priority given to the most populous regions including Oromiya where three-quarters of the administrative *Weredas* (242 out of 261) and 3932 *Kebebles* out of 6107 are considered malarious. Seventeen million people are at risk in Oromiya with annual clinical cases numbering between 1.5 and 2million. This accounts for 20 – 35% of outpatient visits, and 16% of hospital admissions in the region where 18-30% of annual deaths are caused by malaria. [4] While the focus is on Oromiya the initiative has a larger national goal. Twenty million long-lasting insecticide-treated bed nets - LLINs have been distributed to 10 million households (two per household) nationwide with support from Global Fund to Fight AIDS, Tuberculosis and Malaria - GFATM. Of these, 6.5 million were distributed in Oromiya. The proposed fiscal year 2008 PMI budget for Ethiopia is $20 million". [4]

National Goals and Targets of the P(US) resident's Malaria Initiative Adapted to the Ethiopian Reality [4].

The primary objective is to reduce malaria mortality in Ethiopia by 50% by the end of a three-year project period. This is to be achieved through the following planned actions:

- 90% of households with a pregnant women and/or children under-five will own at least one insecticide treated net (ITN);
- 85% of children under-five will have slept under an ITN the previous night;
- 85% of pregnant women will have slept under an ITN the previous night;
- 85% of dwellings in geographic areas targeted for indoor residual spreading (IRS) will have been sprayed;
- 85% of pregnant women and children under five will have slept under an ITN the previous night or in a house that has been sprayed with IRS in the last 6 months;
- 85% of government health facilities have Artemisinine-based Combination Therapy - ACTs - available for treatment of uncomplicated malaria and
- 85% of children under five with suspected malaria will have received treatment with an antimalarial drug in accordance with national malaria treatment policies within 24 hours of onset of their symptoms.

Malaria Ecology: General

Malaria has been a perennial cause of human suffering and mortality for millennia. The Greeks were the first to write about it, and Egyptian hieroglyphs also made a mention of it. It exists throughout much of "…tropical and sub-tropical regions of Africa, Asia, and South and Central America." [5]. A World Health Organization report routinely puts the number of yearly infections at about 300 million and malaria mortality at 2 million a year.

Over 400 species of the malarial parasites (*Plasmodium spp.*) are said to exist. Many infect a wide variety of cold-and-warm-blooded animals. Only four routinely infect humans. Malaria is transmitted from one person to another by the bite of an infected female *Anopheles spp.* mosquito.

> It follows then, that ecological alterations favoring the spread of these insects also facilitate the spread of the infection wherever malaria occurs. To get some idea of the complexity of the ecological differences among the numerous malaria endemic zones, one must consider at least four different, yet related, aspects: the host, the insect vectors, the parasites, and the physical conditions under which transmission occurs. Integration of these seemingly disparate subject areas into a unified view with respect to geographic locale is essential to begin identifying environmental factors that might be taken advantage of for the purpose of controlling the spread of the parasite. [5]

Plasmodia: The Parasite

Malaria is caused by a protozoan belonging to the genus *Plasmodium*. Four species: *Plasmodium falciparum*, *P. vivax*, *P. ovale*, and *P. malariae* infect humans but they each differ in many aspects of their biology and geographic distribution. "*P. falciparum* is found in most tropical regions throughout the world, and is the most dangerous of the four in terms of both lethality and morbidity." All undergo two forms of replication: sexual and asexual. The, parasites develop optimally in the vector but cease developing at temperatures 16°C or below. "High humidity prolongs the life of the vector and transmission is extended under these conditions. In the human intermediate host, the parasite must function at 37°C or higher, since the infection induces a significant rise in core temperature during the height of the infection." [5]

Anopheles mosquito: The Vector

Changes in the environment of the mosquito habitat, such as those taking place in Ethiopia, whether natural or man-made, "… rearranges the ecological landscape in which these vectors breed". Every *Anopheles spp.* occupies a specific "….ecological niche that is genetically determined". Changes in temperature, humidity, altitude, population density of humans, and deforestation are just a few ecological factors that play essential roles in the transmission of malaria. [5].

> Temperature and humidity have a direct effect on the longevity of the mosquito. Each species can thrive at an optimal level as a result of ecological adaptation. The spread of malaria requires that conditions are favorable for

> the survival of both the mosquito and the parasite. Temperatures from approximately 21°-32°C and a relative humidity of at least 60% are most conducive for maintenance of transmission. [5]

In tropical regions temperature and humidity are often mediated by altitude.

> Altitude is significant in determining the distribution of malaria and its seasonal impact on many regions of the world. In Africa, for example, altitudes above 1,000-1,500 m are considered safe from malaria. However, it must be cautioned that with continuing global climate change, these figures may change, extending the range of mosquitoes well above those altitudes as ambient temperatures rise.

The mosquito density (number of female mosquitoes per human inhabitants) is a critical determinant of the intensity of infection. Transmission is directly proportional to density. Mosquito longevity is also a critical factor.

The malaria vector requires water to complete its life cycle – from egg to larva to pupa, and finally an adult mosquito. "While between 200-1000 eggs can be laid, the quantity is influenced by the amount of blood taken in". Blood-feeding usually starts at dusk and continues until dawn. [5].

How does the mosquito vector find the human host?

> Mosquitoes possess a highly developed set of host-detection organs that they use to sense color, light, touch, and temperature, as well as the presence of CO_2. They use all of these sensory inputs to locate a host. When a mosquito has found an appropriate host on which to feed, it uses its two pairs of mandibles and maxillae to penetrate the skin of the animal and pierce a capillary vessel, allowing easy access to blood. It injects numerous biologically active compounds that cause the vessels to dilate blood to flow without coagulation, and to prevent the host from detecting her presence.

Ecological disturbances due to human actions such as deforestation and establishment of new settlements in previously unsettled areas "…allow for the proliferation of mosquitoes that prefer human habitation to natural settings" as does the construction of dams.

> "The breeding sites of infected mosquitoes vary greatly with regards to species. Some prefer clear water, inhabiting the edges of streams, while others thrive in irrigation ditches and reservoirs. Some species require extensive vegetative cover, preferring swamps and other permanent bodies of water laden with dissolved organic matter. Mosquito breeding sites are found anywhere fresh water collects. In fact, there is a direct correlation between the availability of water and the frequency in which mosquitoes feed on humans. Permanent natural bodies of water, such as swamps, serve as unique breeding grounds. Construction of water control projects can also lead to shifts in vector mosquito populations. Reservoirs, irrigation canals, and dams are closely associated with the increase of a variety of parasitic diseases that are water dependent. Throughout the world, especially in developing countries, dams and other related water projects continue to be planned, constructed, and operated to meet human needs such as drinking water, energy generation, and agricultural production. For most countries, dams are a crucial part of economic and social development, and represent a double-edged sword. The potential for dams to alleviate poverty significantly contributes to the enhancement of human health, and simultaneously increases the likelihood of human infection due to schistosomiasis, malaria, dysentery, and river blindness. During the construction of dams and canals, excavation pits provide temporary breeding sites for mosquitos." [5]

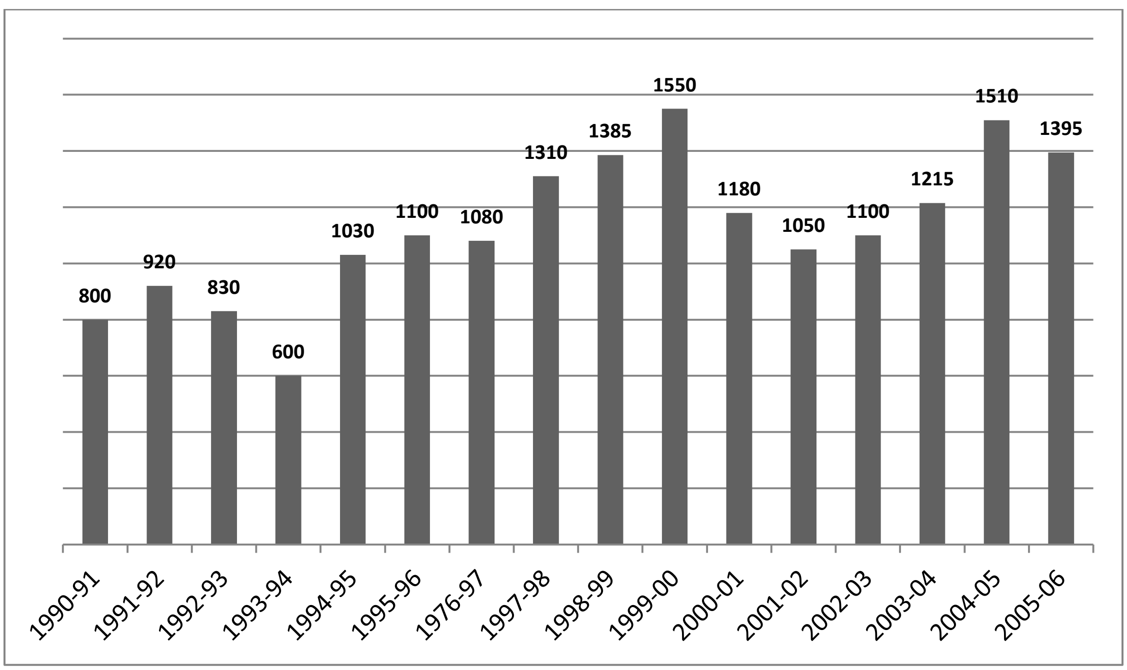
A study in Tigray investigating the possible impacts of small dams on malaria transmission found an unmistakable link. The rate of infection among children near dams was seven times greater than in communities with no dams. The study, thus, concluded that "….microdams close to villages have the potential to increase the incidence of malaria substantially among children living nearby". [6].

Malaria's Disease Burden in Ethiopia

Malaria transmission peaks bi-annually from September to December and April to May [7] coinciding with major harvesting season. Such a coincidence has serious consequences for the subsistence Economy of Ethiopia's countryside and for the nation as a whole. In addition, major epidemics occur every five to eight years with focal epidemics as the commonest form. Figure 14.1 is based on confirmed malaria cases; cases that have come to the attention of health workers and institutions. Overall infection levels estimated at about 5 million a year [8] and incidence of malaria is not only high but rising.

> Approximately 4-5 million cases of malaria are reported annually in Ethiopia and the disease is prevalent in 75 per cent of the country, putting over 50 million people at risk. Malaria accounts for seven per cent of outpatient visits and represents the largest single cause of morbidity. It is estimated that only 20 per cent of children under five years of age that contract malaria are treated at existing health facilities. Below are feature stories related to malaria. [8]

Fig. 14.1 Annual (Confirmed) Malaria Cases (thousands) 1990 – 2006



Source: [7]

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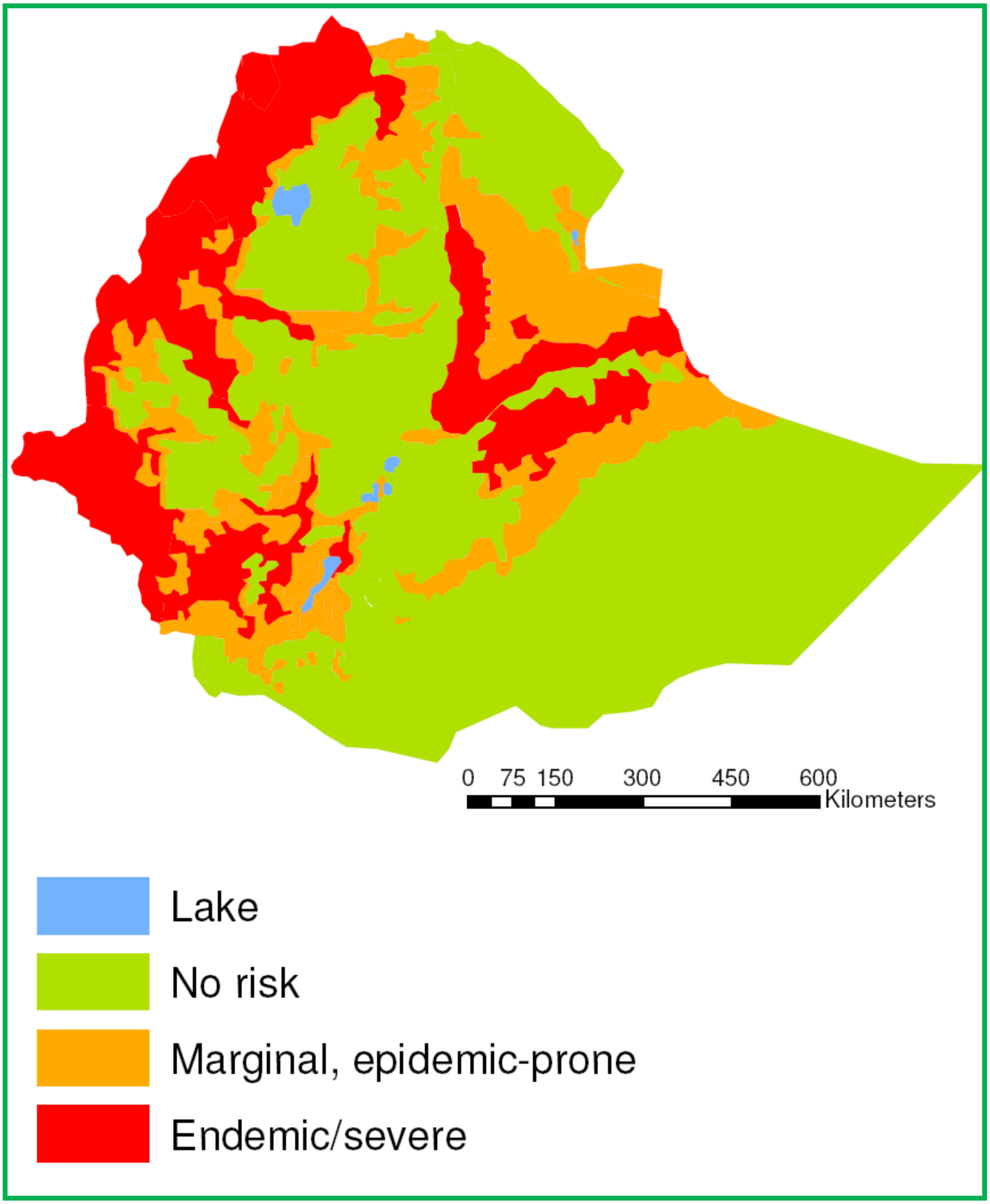
ETHIOPIA: KEY MALARIA FACTS [9]

- Estimated population living in malaria-prone areas: 50 million
- Estimated annual malaria cases: 5 million
- Additional malaria cases in an epidemic year: 6 million
- Number of people dying in a 9-month malaria epidemic (e.g. 2003):114,000
- Estimated number of lives saved if all malaria control interventions fully implemented (Child survival strategy, 2005): 70,400 per year
- Number of ITNs distributed to households since 2005: 4.5 million
- Total number ITNs needed to reach 100% coverage: 20 million
- Coartem doses distributed in public health system: 5.6 million
- Malaria Rapid Diagnostic Test (RDT) kits distributed: 2.2 million

There is a low risk of malarial infection at altitudes above 2000 meters - mostly the Northern and Eastern Highlands. This population above this elevation is in the“negligible risk” category (Figure 14.3) and in the “malaria free” section of Figure 14.2. Regionally, Figure 14.2 shows that all of Gambella in the worst case category – “endemic/severe” –as are most parts of Benishangul-Gumuz. The lower elevations of the Northern and Eastern Highlands are also shown as “endemic/severe”.

> The western, central and eastern highlands, as well as the highland-fringe areas along the Rift Valley are especially vulnerable to epidemics. In all, more than half of the population lives in epidemic-prone areas. Epidemics seem to be intensifying and becoming more widespread. It is estimated that 48 epidemic episodes occurred between 1986 and 1993, with severe outbreaks occurring in 1988, 1991, 1992, 1998, 2003, 2004 and 2005. [4]

Fig. 14.2 Areas of Ethiopia by Malaria Risk Category



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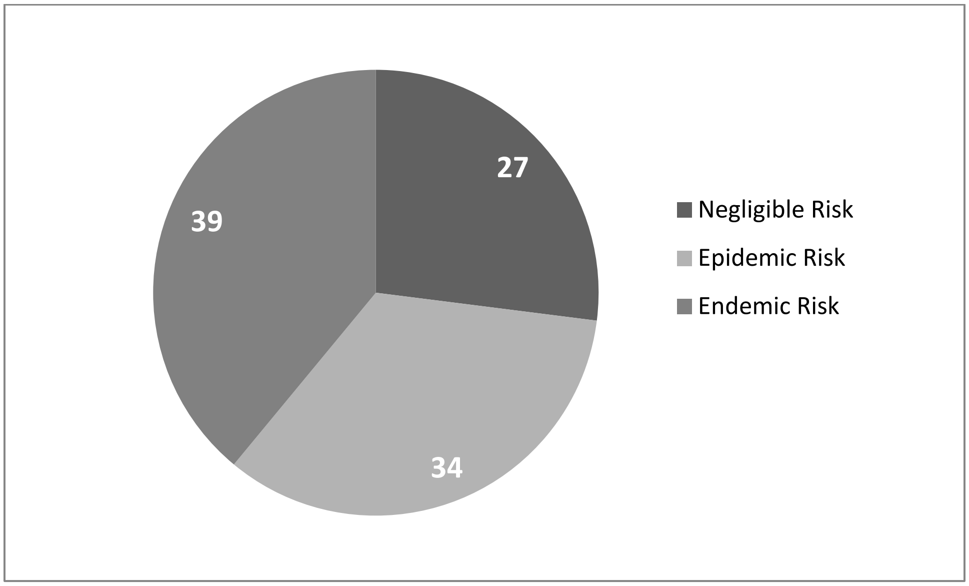
The *Dega* zone of Ethiopia (altitude above 2,500 meters) with a mean annual temperature of 10-15 degree Celsius is malaria-free. Much of the *Woina Dega* zone (Altitude 1500 – 2500 meters) is also malaria free, especially the zone in the 2000 – 2500 meters above sea level. Malaria in Ethiopia "…often occurs below 2000 meters, with short-lived transmission following the rains. However, malaria epidemics have been recorded up to 2400 meters during periods when increased temperature and adequate precipitation are conducive for both vector survival and parasite development within the vector" [11]

Fig. 14.2 Percentage of the Population by Level of Malaria Risk

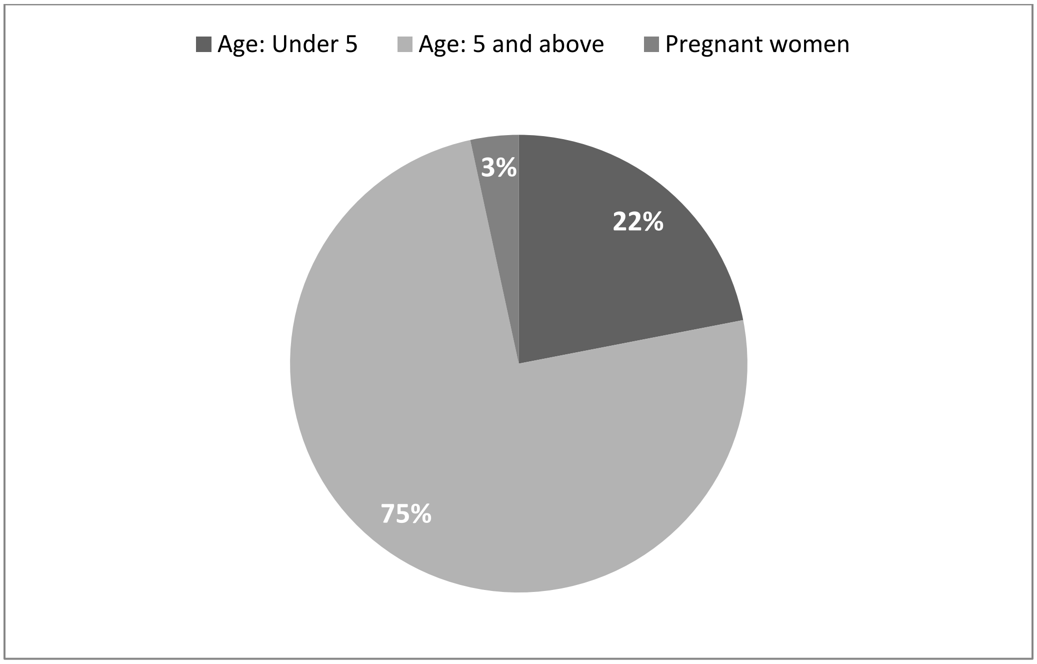


Source: Based on [10]

Percentages are also derived based on the type of malaria parasite involved. "*P. falciparum* accounts for 60% of infections and *P. vivax* for the remainder" [11]. These are transmitted mainly by the vector mosquito *A. arabiensis*. "Forty-two *Anopheles* species have been recorded, with distribution varying by altitudinal zone and microhabitats…While most species are confined to relatively small geographic areas, the four malaria vectors (*A. arabiensis…A. pharoensis, A funestus, A. nili*) are widely distributed" [11]

Figure 14.4 shows age breakdowns for the most recent reporting year published by WHO for Ethiopia.

Fig. 14.4 Percentage of Clinical Malaria Cases Reported in 2001 by Age Group and Pregnancy Status.



Source: [10]

The Role of Human Factors in the Spread of Malaria in Ethiopia

The human factors contributing to the spread of malaria include population mobility, urbanization, water development schemes, agricultural development schemes, conflicts, and improper use of drugs and emerging drug-resistant malaria parasites.

> "Following the end of the civil-war in 1991, significant challenges to malaria control resulted from repatriation of large numbers of displaced Ethiopians from Sudan and settlement of demilitarized personnel…Seasonal migration from highlands to lowlands for agriculture work has increased since 1991 with the growth of large-scale agricultural development projects. Western lowland district populations have increased by 20-30% with the arrival of tens of thousands of agricultural workers during the harvest season, which is also the high transmission season for malaria…Laborers often work during the cooler evening hours when vector-biting rates are high, and often sleep in the fields…Land scarcity in the highlands resulted in establishment of new villages for settlement in western malarious lowlands"[11]

The low level of urbanization in Ethiopia (16%) masks recent trends of substantial increases in urban growth rates. The chapter on migration and urbanization showed hundreds of localities with a growth rate of 6% or higher (twice the national rate of population growth).

> "A plethora of man-made breeding sites exist in urban areas and include construction of borrow pits and brick-making pools, garbage dumps, old tires, and discarded containers in household and office compounds…Urban areas have also traditionally not been included in spray operations or bed-net distribution programs because of resource constraints and the good access of urban dwellers to health institutions. When favorable climatic conditions for transmission exist, the high urban population density, the presence of multiple breeding sites, the lack of indoor residual spray, and lower household bed-net coverage, allow for rapid spread of malaria." [11]

Recurrent drought has shaped much of Ethiopia's recent economic history. Among the strategies embarked on by the country's government is a shift away from rain-fed agriculture to "…small-scale irrigation agriculture through run-off harvesting in microdams and ponds" [11]. Large-scale irrigation agriculture has also been in existence for decades as is the practice of damming rivers for the production of hydro electric power. None of these have been without health consequences, however, and the toll in malaria illnesses and death has been documented [12]. As is the case in other tropical countries, river-fed agriculture has led to the resurgence of malaria even in areas where its threats have been receding. What is good for crops like cotton and sugar cane – high temperature and plenty of water – is also a heaven for the malaria vector. The Awash River Valley is the most developed in terms of irrigation agriculture. "The relation between irrigated crops and the presence of malaria has long been noted in the Awash Valley plantations of sugarcane, fruit, and cotton…and the introduction of irrigated rice cultivation in parts of Gambella has been suggested as an important contributing factor in malaria transmission" [11]

The low educational level of malaria sufferers most of whom live in the countryside and have never been to school leads to failure to adhere to drug regimens or to premature stoppage of upon a mistaken sense of early return to full health. As is the case elsewhere where malaria is endemic drug-resistance has been the inevitable outcome in many parts of Ethiopia. There is no national study on drug resistance in Ethiopia but isolated studies have shown drug resistance to SP to be less than 5% in Humera and as high as 18% in Zway (1998), and even higher in another study of Zway (30%) conducted by the Institute of Pathology in 2000 [13].

There are drug-resistance monitoring sites in Ethiopia [13] keeping records of the use/misuse of antimalarials such as SP (Sulfadoxine-Pyrimethamine). Other anti malaria drugs in Ethiopia to which the parasite has developed resistance includes AL (Artemether-Lumefantrine). In a related study, the authors Tedros Adhanom et. al [11] have warn that "the high resistance level of P. falciparum to the relatively cheap SP warrants … an immediate review…" and suggested that "safe and effective alternative ACTs [Artemisinine-based Combination Therapy] such as AL should be incorporated into the treatment guideline as early as possible"

The Socio-Economic Impacts of Malaria in Ethiopia.

Up to 2 million people die of malaria around the world annually (mostly in Africa) and half of them are children. The overall cost of malaria in Africa is summarized as follows [14]:

- An estimated 300 million cases of acute malaria occur each year globally.
  - 90 percent of the 2 million malaria deaths occur in Africa, mostly in young children and especially in sub-Saharan Africa.
- Malaria is the leading cause of mortality in African children under-five.
- The deadliest form of the malaria parasite, *Plasmodium falciparum,* is most commonly found in Africa.
- The economic cost of malaria is estimated to be more than $12 billion a year in lost productivity.
- Throughout Africa, resistance to chloroquine, the cheapest and most widely used antimalarial drug, is common.
- Sulfadoxine-pyrimethamine (SP), often seen as the first and least expensive alternative to chloroquine is also among drugs to which resistance has developed, especially in East and Southern Africa.
- ITNs around sleeping areas may reduce malarial deaths in young children by an average of 20 percent. But the nets are expensive for the families most at-risk of malaria, who are among the poorest in the world.
- The World Health Organization (WHO) has recently backed a new, limited time policy to spray DDT inside homes.

Studies commonly refer to malaria as "…the number one health problem in Ethiopia" [15]. The disease is ranked as the leading communicable disease in Ethiopia "… accounting for approximately 30% of the overall Disability Adjusted Life Years (DALYs) lost" and causes about 70,000 deaths each year [4]. It is estimated that over five million episodes of malaria occur each year in Ethiopia [11].

> "The burden of malaria has been increasing due to a combination of large population movements, increasing large-scale epidemics, mixed infections of *Plasmodium vivax* and *P. falciparum*, increasing parasite resistance to malaria drugs, vector resistance to insecticides, low coverage of malaria prevention services, and general poverty. Outpatient consultations, inpatient admissions and all in-patient deaths have risen by 21-23% over the last five years. Overall, malaria accounts for approximately 17% of outpatient consultations, 15% of admissions and 29% of in-patient deaths. However, as 36% of the population is out of reach of the health service coverage, these figures may under-represent the true situation." [4]

Quantification of the socioeconomic burden of malaria in Ethiopia is problematic since the victims live mostly in rural areas out of sight and out of mind, but some estimates abound:

> "The social and economic consequences of the disease are sobering, with a large number of people kept from work by debilitating illness resulting in low productivity… While household malaria burden is likely to be underestimated by institution data, routine health reports clearly reveal the burden of Malaria on the health system. According to annual national health indicator reports, malaria has consistently ranked in the top 10 causes of outpatient visits, admissions, and death at health centers and hospitals for the past seven years" [11]

The Ministry of Health (quoted in [15]) summarized Malaria's socio-economic impacts in Ethiopia as follows:

- The high morbidity and mortality rate in the adult population significantly reduces production activities;
- The prevalence of malaria in many productive parts of the country prevents the movement and settlement of people in resource-rich low-lying river valleys. On the flip side, the concentration of population in non-malaria risk highland areas has resulted in a massive environmental and ecological degradation and loss of productivity, exposing a large population of the country to repeated droughts, famine and poverty;
- The increased school absenteeism during malaria epidemics significantly reduces the learning potentials of students;
- Coping with malaria epidemics overwhelms the capacity of health services in Ethiopia to focus on other diseases, and thus substantially increases public health expenditures.

The facts outlined above make malaria in Ethiopia not just a health issue but a food-security and environmental issue as well. The malaria season coincides with peak economic activity in rural Ethiopia when both rainfall levels and temperature are high and conducive for the growing of subsistence crops. Vector activity peaks in periods often set aside for cultivation, weeding, harvesting and winnowing. Weddings and other culturally important activities also peak at this time. In other words, optimal climatic regimes for socio-economic activities in rural Ethiopia also favor the reproduction, propagation, and intensified vector activities. In a study by Gabriel Senay and James Verdin's [15] the link between temperature/rainfall on the one hand and infection rates on the other was strong They show that infection rates have been increasing sharply in recent years. This could be attributed partly to better reporting of cases due to increased accessibility to health centers and larger institutions catering to the needs of malaria patients.

Are Current Prevention and Control Strategies Succeeding?

Figures published by the Government of Ethiopia suggest considerable gains in its ongoing efforts to tame malaria and lessen the impacts of the disease on society, health, and economy. The following are among the main policy goals and achievements reported [16]:

Technical Elements and Strategic Approaches:

- Guided focus on early diagnosis and effective treatment
- Persistent efforts in vector control
- Easy and universal accessibility to ITNs
- Residual periodic spray of dwellings
- Other vector control methods;
    - Environmental management,
    - Larviciding etc
- Continued efforts in epidemic prevention

Supporting Strategies:

- Man-power: trained human resource development
- R &D Focus on operational research and development
- Expanded use of information technologies, education, and communication
- Effective and permanent program monitoring and evaluation

Vision, Mission, and Goals

• Vision:

– Roll Back Malaria: The vision of malaria prevention and control in Ethiopia is to achieve and maintain an environment in which malaria ceases to be a significant public health problem and an obstacle to socio-economic development.

• Mission:

– The mission of the Federal Ministry of Health (FMOH) Malaria Prevention and Control program is:

"– to expand and maintain high quality service for malaria prevention and control with special emphasis on ensuring access to early and equitable services for the population at risk of malaria with special emphasis to the most vulnerable population groups."

- **Goals**

• To contribute to MDGs Goal 6 Target 8 by reducing the overall burden of malaria (mortality and morbidity) by 50 percent by the year 2010, compared to the baseline level (2005),
• To contribute to the reduction of child mortality (MDG Goal 4) and enhanced maternal health

Impact Objectives

• **By 2010:**

• Reduce morbidity attributable to malaria from 22 percent to 10 percent
• Reduce malaria case-fatality rate in under-5 children from 5.2 percent to 2 percent
• Reduce case-fatality rate of malaria in age groups 5 years and above from 4.5 percent to 2 percent

Specific Objectives

• Achieve a full (100 percent) access to effective and affordable treatment for malaria by the end of 2008
• Attain a full (100 percent) coverage in ITNs (insecticide treated nets) targeted districts with two ITNs per household by 2007, (Polygamous family considered as different families)
• Achieve a 60% coverage of villages targeted for Indoor Residual Spraying (IRS) by the end of 2010 as compared to the 25% coverage in 2005,
• Detect and contain 80% of the malaria epidemics within two weeks from onset by 2010 as compared to 31% in 2005." [16]

Achievements so far: Vector Control/ITNs

Vector Control: ITNs/LLINs (Long-Lasting Insecticide-treated bed net)

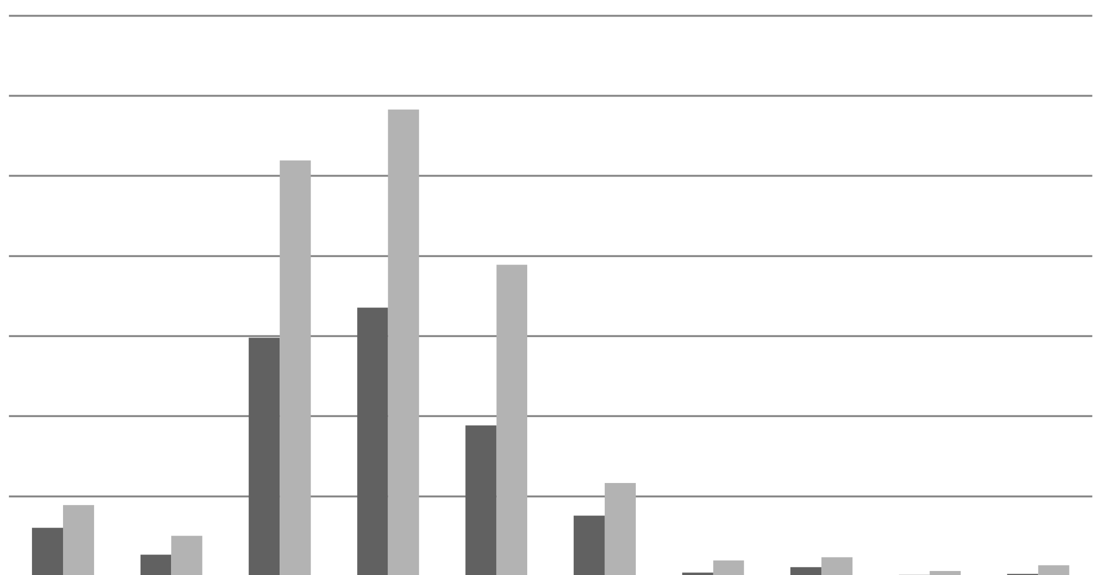
- 18.2 million ITNs/LLIN have been distributed to users so far
- 5,108,168 nets have been procured or in pipeline
- coverage of 88% at 2 ITNs/LLIN per household

Challenges and constraints: ITNs

• Insufficient knowledge of ITN usage which requires changes in community life-styles
• Lack of national (large scale) studies/surveys on ITNs utilization
• Shortage of skilled health workers (HW) for the national malaria control program (at regional and district levels)
• The government needs to remove taxes and tariffs completely.
• Better design and customization of ITN colors and shapes
• Maintaining a high level of LLIN coverage through timely replacement of damaged or worn-out LLINs.
• Establish a user-response system for LINs efficacy- by eliciting comments from the general public.
• Undertake a though analysis of mosquito behavior (e.g. whether or not it is an early biter) and its sleeping behavior
• The malaria control program is labor intensive and requires specialized equipment

- Replastering of walls reduces the potency of spray drugs
- In places where vectors feed and rest outdoors, spraying is often ineffective
- Extra commitments resulting from overlap between IRS and ITNs distribution
- Overall shortage of operational budget
- Unresolved shortage of supplies (chemicals spray pumps and spare parts)
- Sustainability of spraying in question due to inadequacy of resources

Figure 14.6 Number of Households at the Risk of Malaria Infection and Number of Insecticide Treated Nets (ITNs) by Region.



	Tigray	Afar	Amhara	Oromia	SNNPR	Somali	Gambella	Benishan gul G.	Harari	Dire Dawa
No. ITNs	608114	271744	2980168	3356227	1883662	759294	48079	114588	18955	30682
No. Households	888573	505096	5192398	5827599	3889237	1166069	197900	240600	69089	137314

Source: Based on [16]

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