# Malaria

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# Objectives:

- Epidemiology of malaria
- Clinical picture
- Mode of transmission
- Risk factors
- Prevention and control

- Malaria is a life-threatening disease caused by **Plasmodium parasites** that are transmitted to people through the **bites of infected mosquitoes.**

- Nearly half of the world's population is at risk of malaria.

- Young children, pregnant women and non-immune travelers from malaria-free areas are particularly vulnerable to the disease

# High risk groups

**Malaria in pregnant women**

Malaria in pregnancy increases the risk of maternal and fetal anaemia, stillbirth, spontaneous abortion, low birth weight and neonatal death.

**Malaria in infants**

Infants born to mothers living in endemic areas are vulnerable to malaria from approximately 3 months of age, when immunity acquired from the mother starts to wane.

**Malaria in children under five**

In high-transmission areas of the world, children under 5 years of age (including infants) are the most vulnerable group.

**Malaria in HIV/AIDS patients**

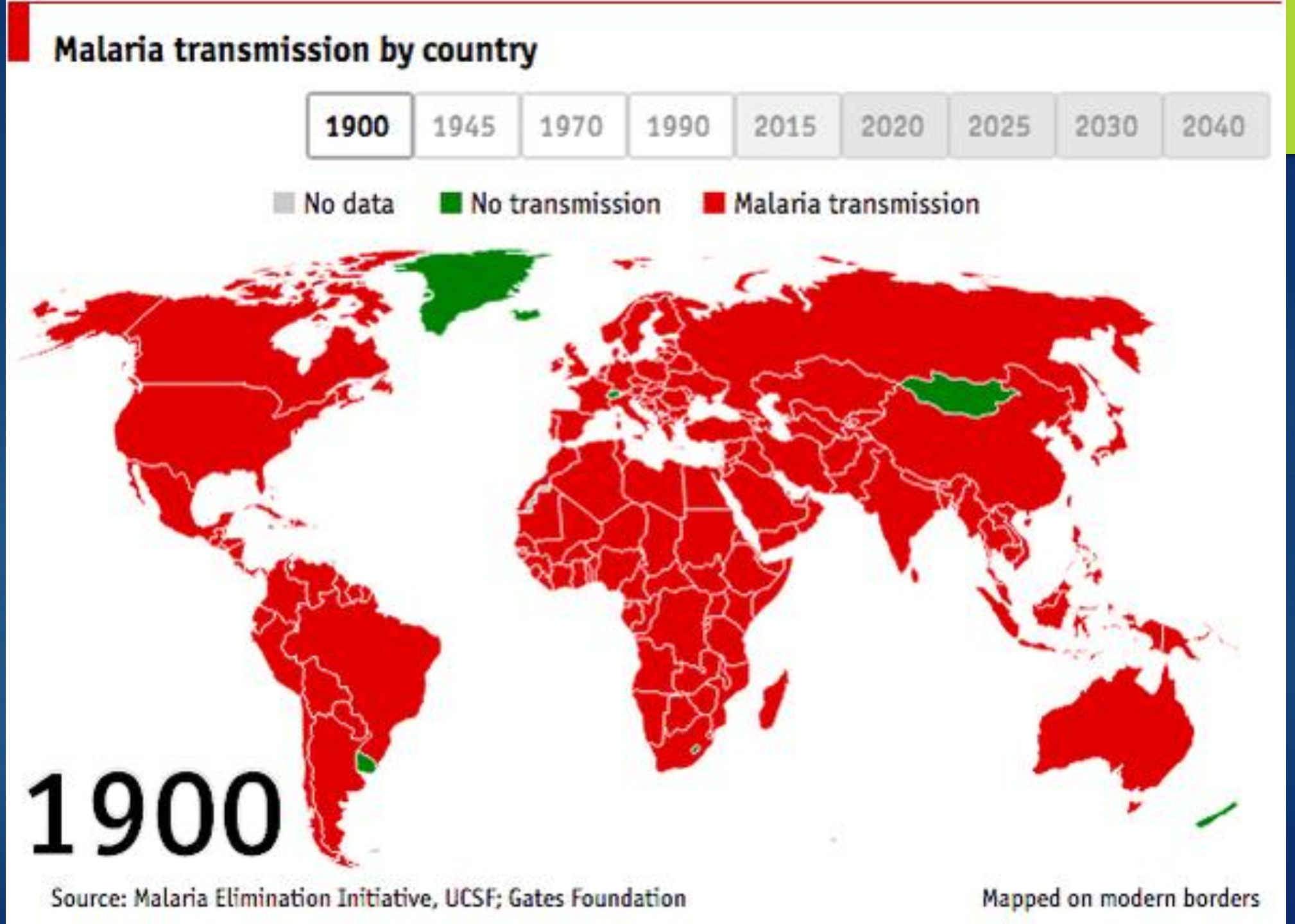
Co-infection and interaction between these two diseases have major public health implications. HIV infection increases the risk of malaria infection, severe malaria and death, while malaria may result in the worsening of clinical AIDS.

**Malaria in migrants and mobile populations**

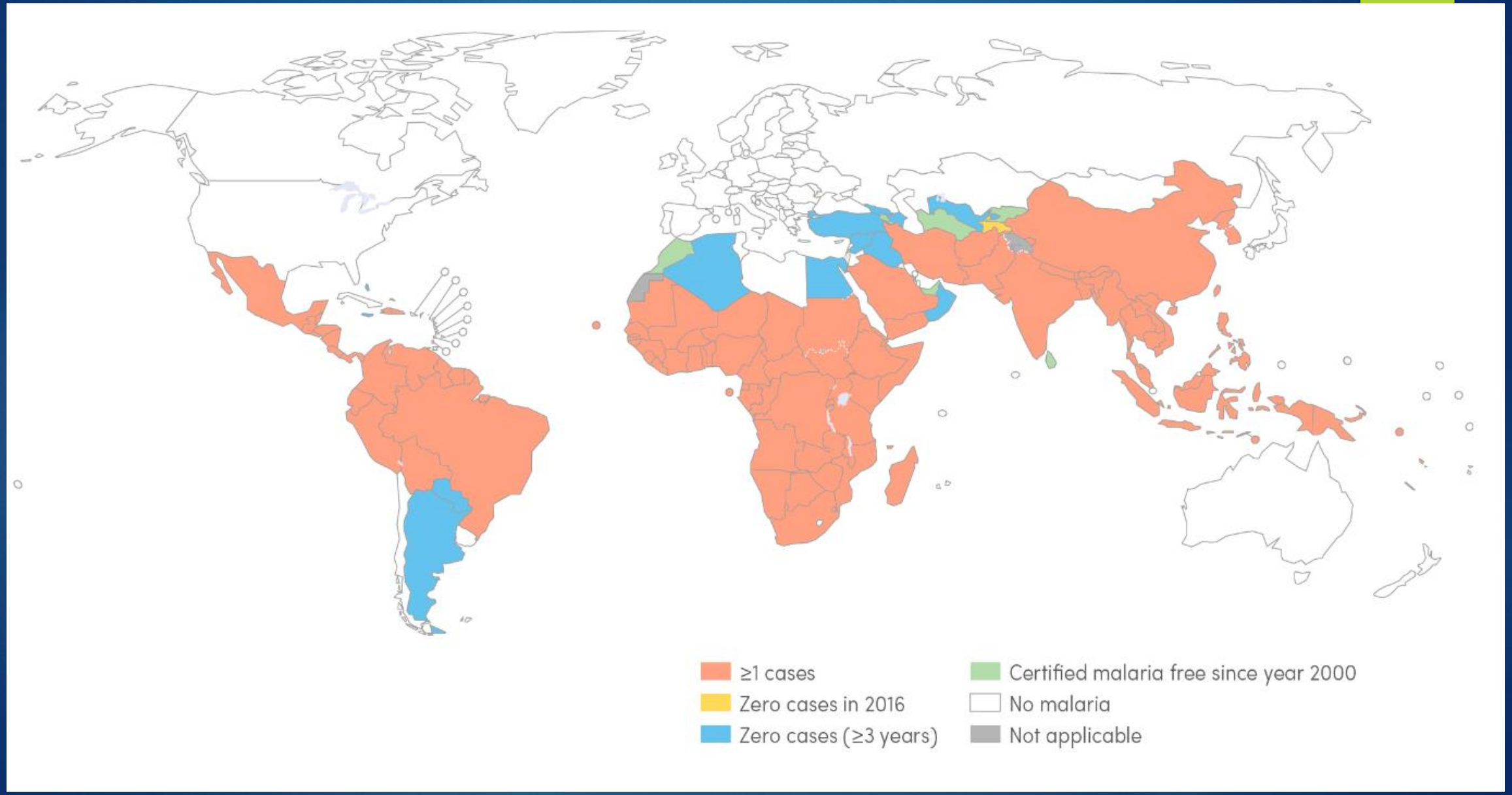
Migrants, refugees and other mobile population groups often lack partial immunity to malaria, and have limited access to prevention, diagnostic testing and treatment services.

# Definitions

- • Malaria elimination: "interruption of local transmission of a specified malaria parasite species in a defined geographical area as a result of deliberate activities. Continued measures are required to prevent re-establishment of transmission."
- • "Certification of malaria elimination: granted by WHO after proving beyond reasonable doubt that the chain of local malaria transmission by Anopheles mosquitoes has been fully interrupted in an entire country for at least three consecutive years."
- •"When a country has zero locally acquired malaria cases for at least three consecutive years, it can request WHO to certify its malaria-free status".


Malaria transmission by country
1900
1945
1970
1990
2015
2020
2025
2030
2040
No data
No transmission
Malaria transmission
1900
Source: Malaria Elimination Initiative, UCSF; Gates Foundation
Mapped on modern borders

# Countries with indigenous cases in 2000 and their status by 2016



# Malaria cases

- In 2016, an estimated 216 million cases of malaria occurred worldwide
- Most malaria cases in 2016 were in the WHO African Region (90%), followed by the WHO South-East Asia Region (7%) and the WHO Eastern Mediterranean Region (2%)
- Of the 91 countries reporting indigenous malaria cases in 2016, 15 countries – all in sub-Saharan Africa, except India – carried 80% of the global malaria burden.
- In 2016, there were an estimated 445 000 deaths from malaria globally
- The WHO African Region accounted for 91% of all malaria deaths in 2016, followed by the WHO South- East Asia Region (6%).
- More than two-thirds (70%) of all malaria deaths occur in children under 5.

# Estimated number of malaria deaths by WHO region, 2010-2016

| | Number of deaths | | | | | | |
|---|---|---|---|---|---|---|---|
| | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** |
| African | 538 000 | 484 000 | 445 000 | 430 000 | 423 000 | 409 000 | 407 000 |
| Eastern Mediterranean | 7 200 | 7 100 | 7 700 | 7 800 | 7 800 | 7 600 | 8 200 |
| European | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Americas | 830 | 790 | 630 | 620 | 420 | 450 | 650 |
| South-East Asia | 41 700 | 34 000 | 29 000 | 22 000 | 25 000 | 26 000 | 27 000 |
| Western Pacific | 3 800 | 3 300 | 4 000 | 4 300 | 2 900 | 2 600 | 3 300 |
| **World** | **591 000** | **529 000** | **487 000** | **465 000** | **459 000** | **446 000** | **445 000** |

# Every 2 minutes

malaria kills a child under the age of 5. Children remain one of the most vulnerable groups affected by the disease.

World Health Organization

#Malaria

# 46%

of people at risk of malaria in sub-Saharan Africa are not protected by insecticide-treated bednets.

World Health Organization

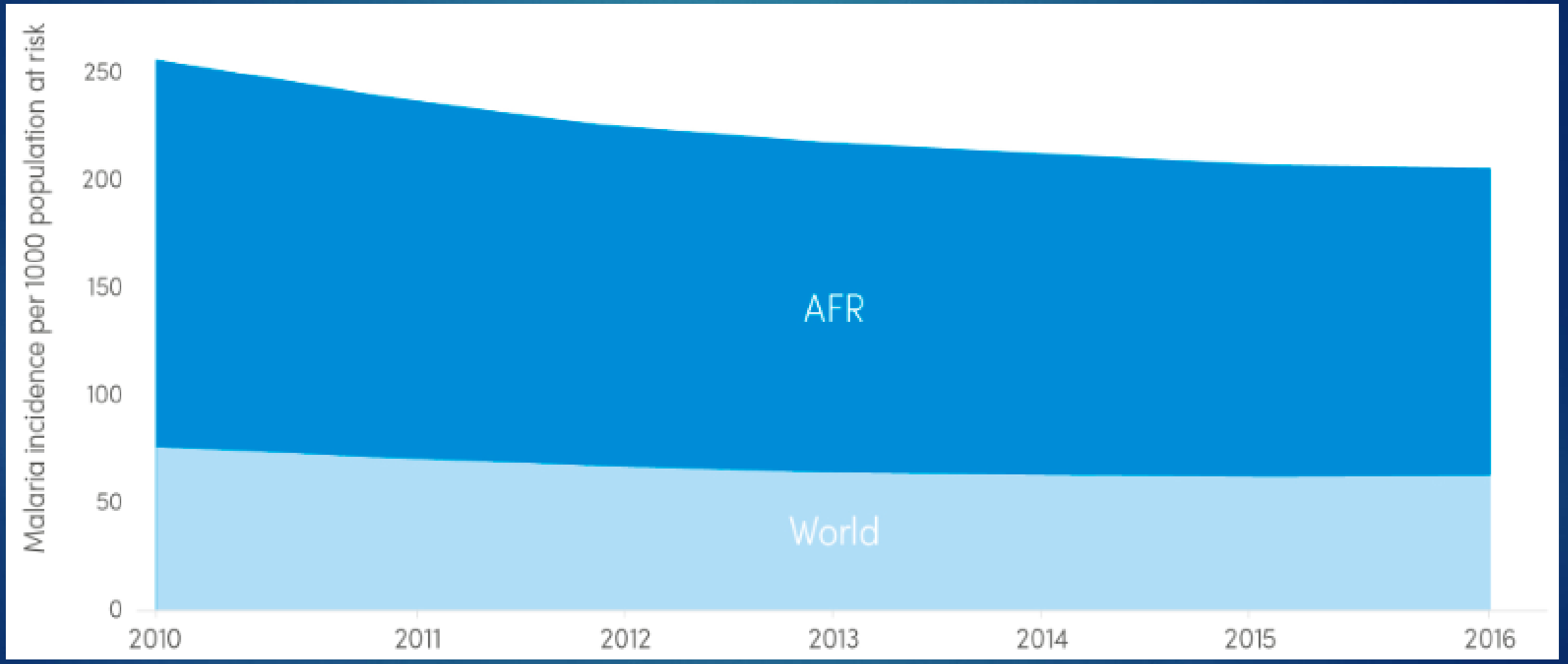
#Malaria

# Trends in indigenous malaria cases in the E-2020 countries

| WHO region | Country | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Change 2015 to 2016 |
|---|---|---|---|---|---|---|---|---|---|
| African | Algeria | 1 | 1 | 55 | 0 | 0 | 0 | 0 | 0 |
| | Botswana | 7 592 | 1 223 | 537 | 1221 | 3 594 | 878 | 1 911 | +1 033 |
| | Cabo Verde | 47 | 7 | 1 | 22 | 26 | 7 | 48 | +41 |
| | Comoros | 36 538 | 24 856 | 49 840 | 53 156 | 2 203 | 1 300 | 1 066 | −234 |
| | South Africa | 8 060 | 9 866 | 5 629 | 8 645 | 11 705 | 555 | 4 323 | +3 768 |
| | Swaziland | 268 | 549 | 562 | 962 | 711 | 157 | 350 | +193 |
| Americas | Belize | 150 | 72 | 33 | 20 | 19 | 9 | 4 | −5 |
| | Costa Rica | 110 | 10 | 6 | 0 | 0 | 0 | 4 | +4 |
| | Ecuador | 1 888 | 1 219 | 544 | 368 | 242 | 618 | 1 191 | +573 |
| | El Salvador | 19 | 9 | 13 | 6 | 6 | 3 | 13 | +10 |
| | Mexico | 1 226 | 1 124 | 833 | 495 | 656 | 517 | 551 | +34 |
| | Paraguay | 18 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Suriname | 1 712 | 771 | 356 | 729 | 401 | 81 | 76 | −5 |
| Eastern Mediterranean | Iran (Islamic Republic of) | 1 847 | 1 632 | 756 | 479 | 358 | 167 | 84 | −83 |
| | Saudi Arabia | 29 | 69 | 82 | 34 | 30 | 83 | 272 | +189 |
| South-East Asia | Bhutan | 436 | 194 | 82 | 15 | 19 | 34 | 15 | −19 |
| | Nepal | 43 377 | 32 650 | 20 542 | 16 241 | 8 033 | 6 599 | 4 218 | −2 381 |
| | Timor-Leste | 113 260 | 36 185 | 8 078 | 1 564 | 521 | 122 | 143 | +21 |
| Western Pacific | China | 4 990 | 3 367 | 244 | 86 | 56 | 39 | 3 | −36 |
| | Malaysia | 5 194 | 3 954 | 3 662 | 2 921 | 3 147 | 242 | 266 | +24 |
| | Republic of Korea | 1 267 | 505 | 394 | 383 | 557 | 627 | 601 | −26 |

E-2020, malaria eliminating countries for 2020

# Trends in malaria case incidence rate, 2010 - 2016



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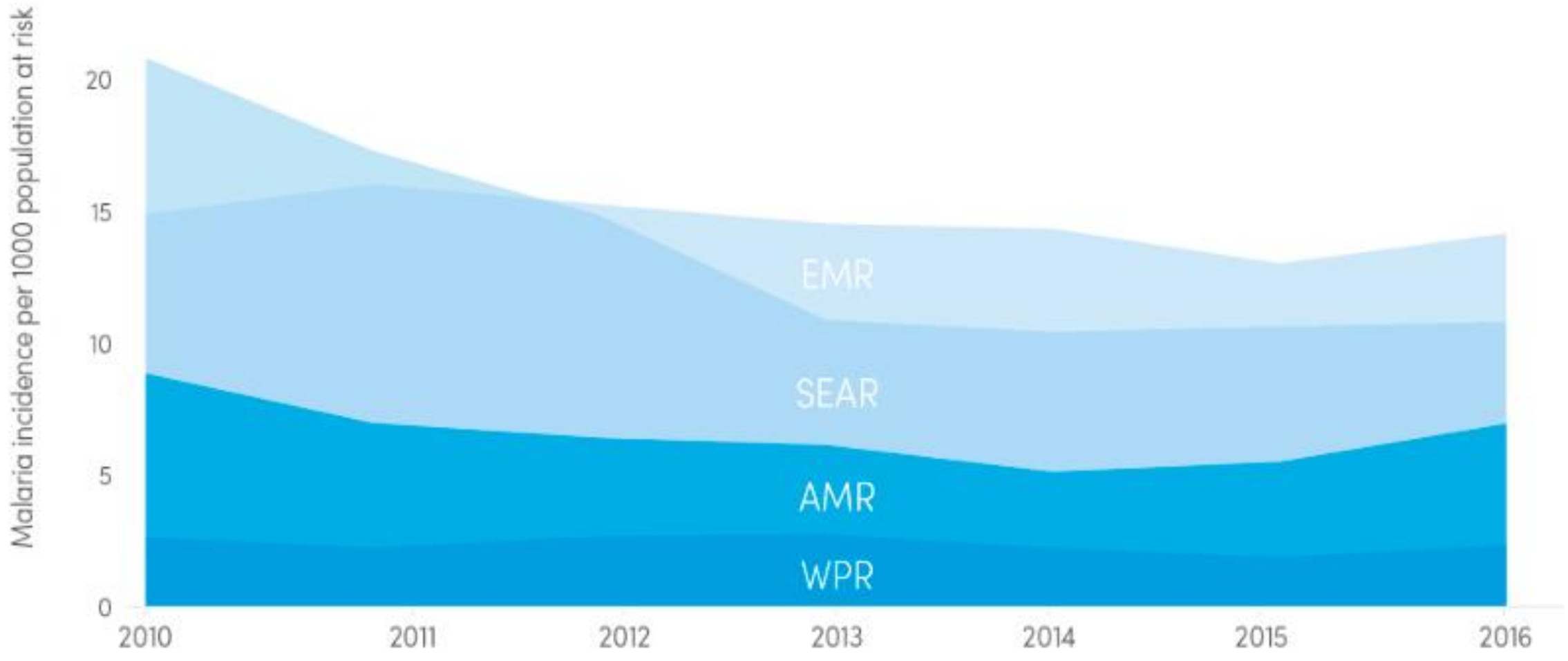
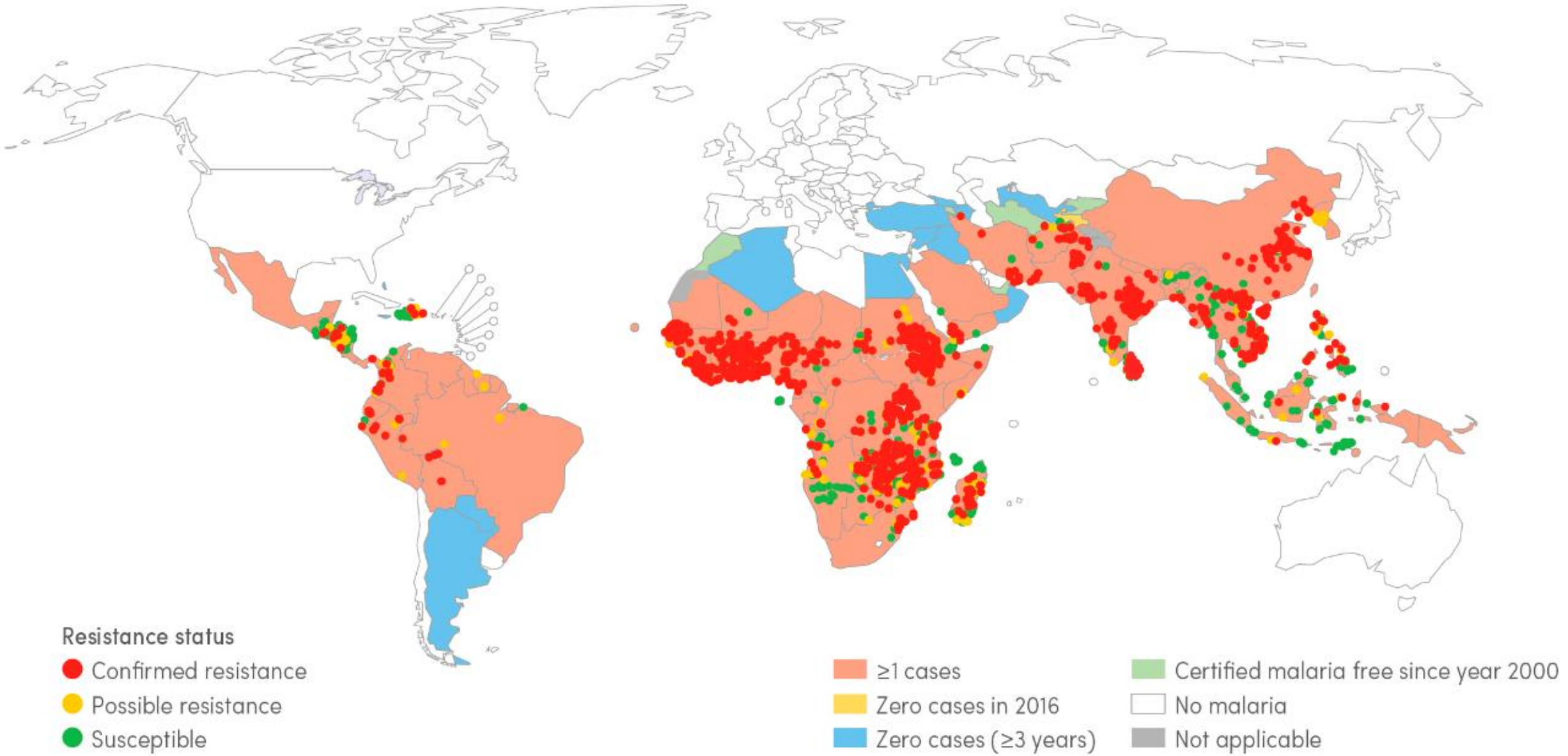



AFR, WHO African Region; AMR, WHO Region of the Americas; EMR, WHO Eastern Mediterranean Region; SEAR, WHO South-East Asia Region; WPR, WHO Western Pacific Region

# Epidemiology

- The incidence rate of malaria is estimated to have decreased by 18% globally, from 76 to 63 cases per 1000 population at risk, between 2010 and 2016.
- During the same period, malaria **mortality** rates decreased worldwide by 60% among all age groups, and by 65% among children under 5.
- An estimated 6.2 million malaria deaths have been averted globally since 2000.
- In 2014, 13 countries reported zero cases of the disease and 6 countries reported fewer than 10 cases.

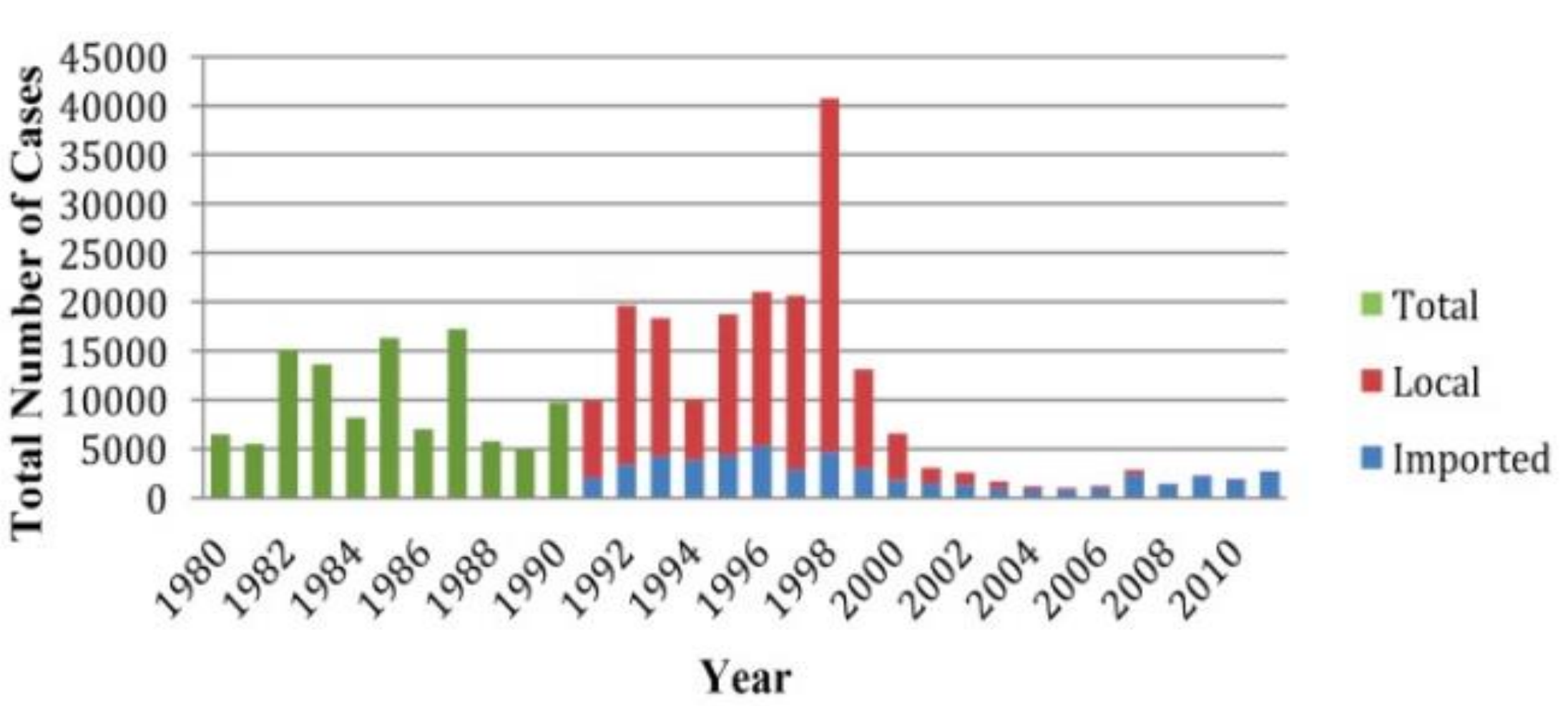
# Reported pyrethroid resistance status of malaria vectors, 2010-16



# Malaria in Saudi Arabia

- Areas at the **southern region** are at risk of malaria transmission, specifically Asir and Jizan. The Dominant Malaria Species in Saudi Arabia is P. Falciparum .
- Saudi Arabia achieved a decrease in malaria cases and case incidence rates of ≥75%.

# Indigenous cases of malaria Saudi Arabia 2014 :



# Imported malaria in Saudi Arabia 1999-2010 :

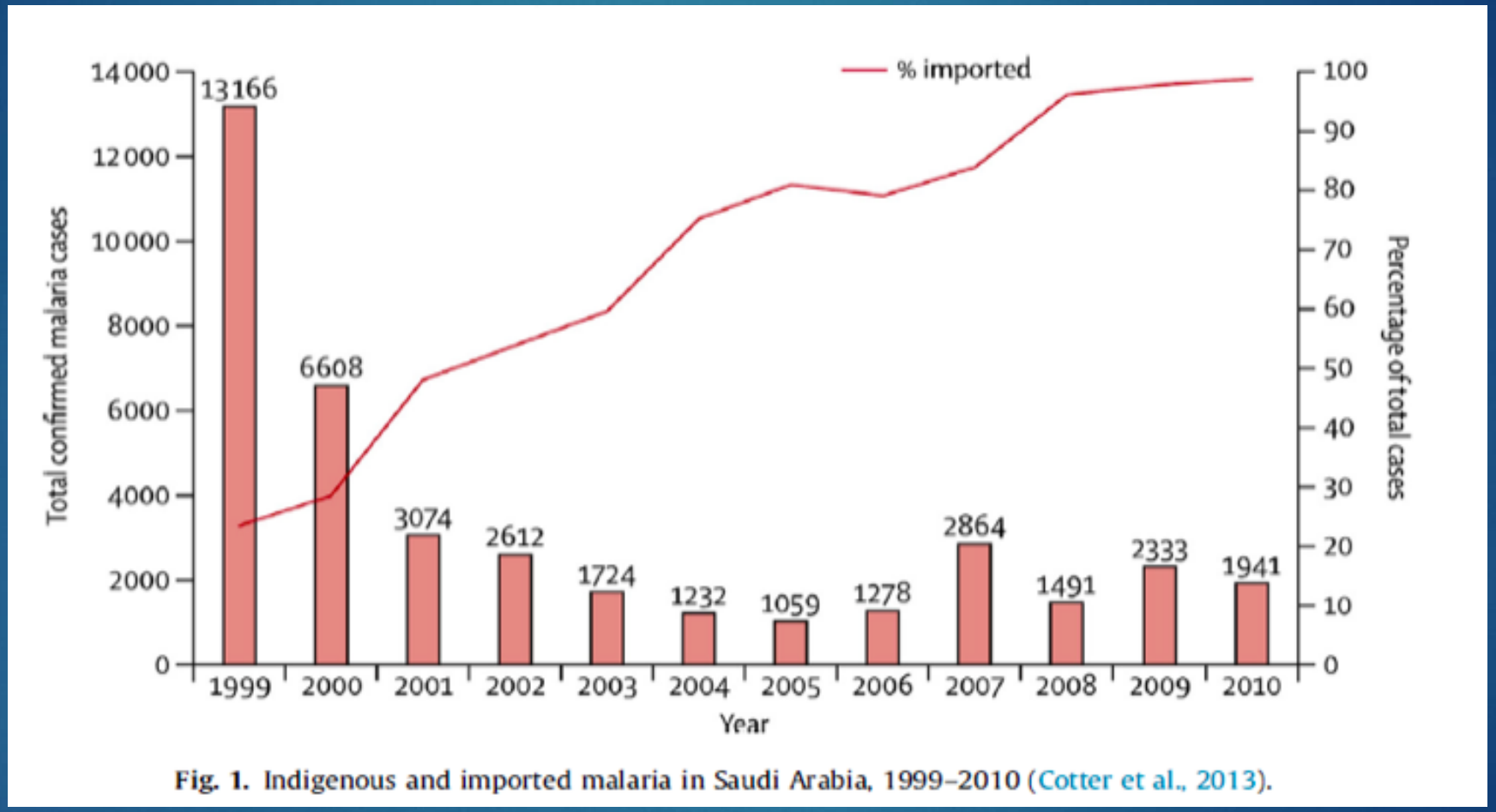



**Fig. 1.** Indigenous and imported malaria in Saudi Arabia, 1999–2010 (Cotter et al., 2013).

# Malaria in Saudi Arabia

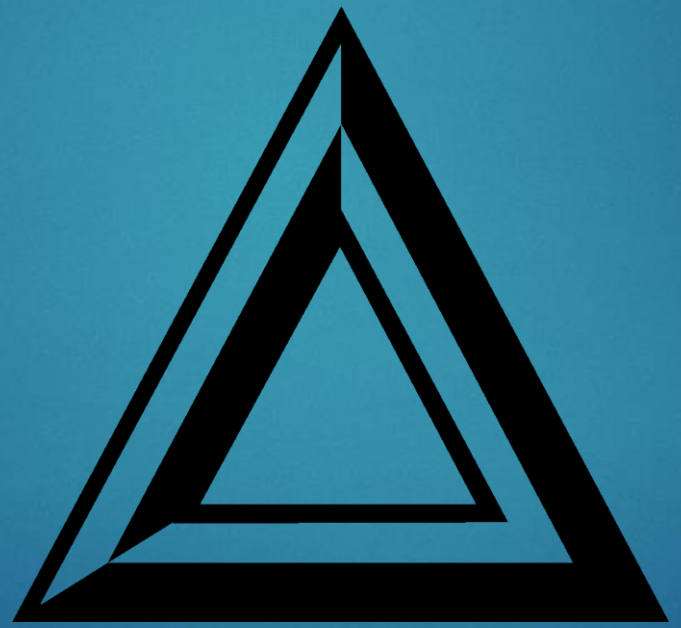
- Malaria outbreak in 1998.
- Since then, only a few cases were reported
- In 2012 , only 82 cases of malaria were reported..
- The proportion of imported malaria has increased from 23% to 99% of total detected cases.

- **Imported malaria:** via asymptomatic travelers from malaria endemic areas, sustains a threat for possible resurgence of local transmission:

  Workers, immigrants, pilgrims.

# Analytical Epidemiology Triad:

HOST



AGENT

ENVIRONMENT

# Species affecting humans

- ***P. falciparum***, which is found worldwide in tropical and subtropical areas, and especially in Africa where this species predominates. *P. falciparum* can cause severe malaria because it multiples rapidly in the blood, and can thus cause severe blood loss (anemia). In addition, the infected parasites can clog small blood vessels. When this occurs in the brain, cerebral malaria results, a complication that can be fatal.
- ***P. vivax***, which is found mostly in Asia, Latin America, and in some parts of Africa. Because of the population densities especially in Asia it is probably the most prevalent human malaria parasite. *P. vivax* (as well as *P. ovale*) has dormant liver stages ("hypnozoites") that can activate and invade the blood ("relapse") several months or years after the infecting mosquito bite.
- ***P. ovale*** is found mostly in Africa (especially West Africa) and the islands of the western Pacific. It is biologically and morphologically very similar to *P. vivax*. However, differently from *P. vivax*, it can infect individuals who are negative for the Duffy blood group, which is the case for many residents of sub-Saharan Africa. This explains the greater prevalence of *P. ovale* (rather than *P. vivax* ) in most of Africa.
- ***P. malariae***, found worldwide, is the only human malaria parasite species that has a quartan cycle (three-day cycle). (The three other species have a tertian, two-day cycle.) If untreated, *P. malariae* causes a long-lasting, chronic infection that in some cases can last a lifetime. In some chronically infected patients *P. malariae* can cause serious complications such as the nephrotic syndrome.
- ***P. knowlesi*** is found throughout Southeast Asia as a natural pathogen of long-tailed and pig-tailed macaques. It has recently been shown to be a significant cause of zoonotic malaria in that region, particularly in Malaysia. *P. knowlesi* has a 24-hour replication cycle and so can rapidly progress from an uncomplicated to a severe infection; fatal cases have been reported.

# Reservoir

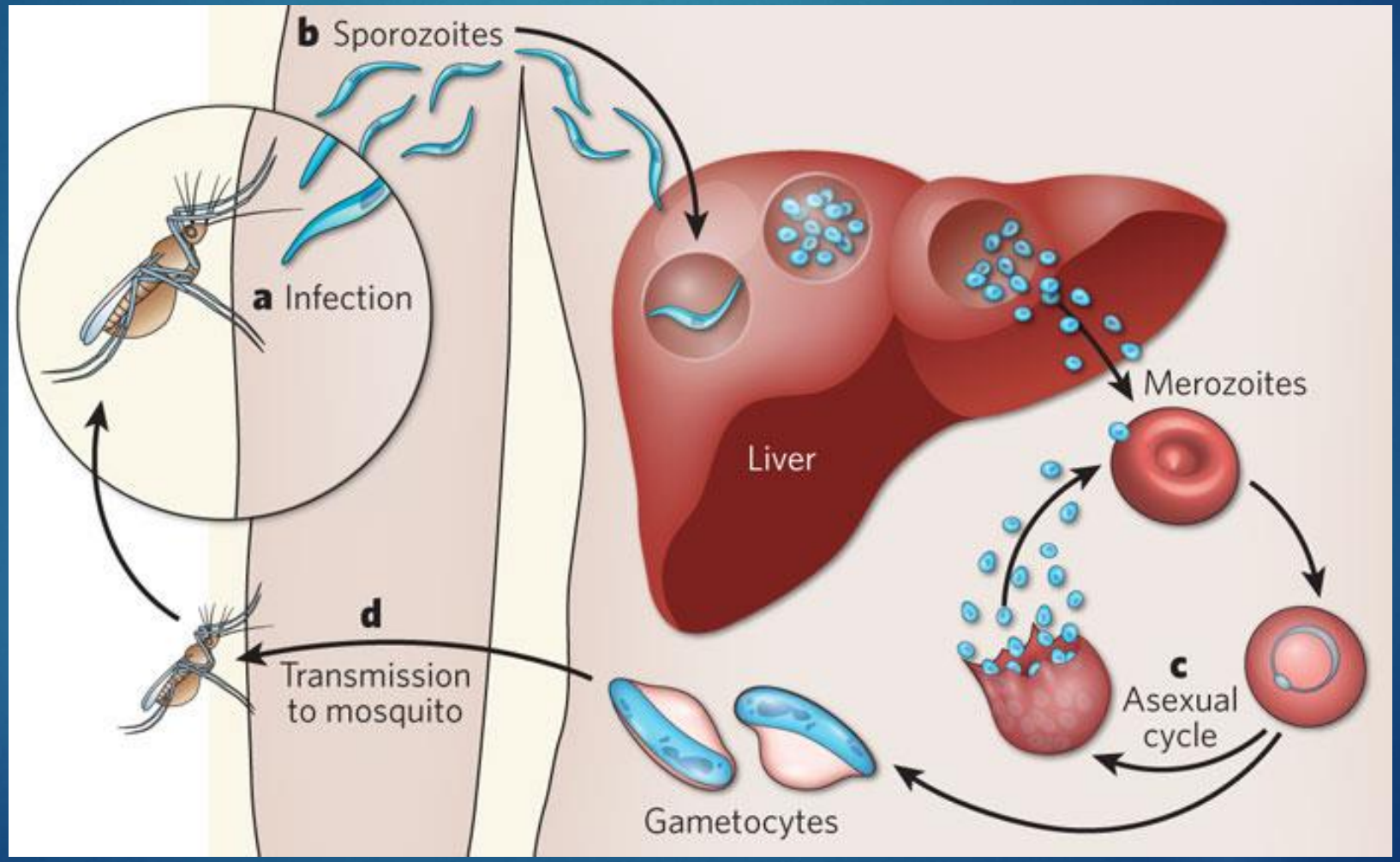
- *A human reservoir is one who harbors the sexual forms of the parasite*
- *Children are more likely to be gametocyte carriers than adults*
- *The child is thus epidemiologically a better reservoir than the adult*
- *P. knowlesi* is a species that naturally infects macaques living in Southeast Asia. Humans living in close proximity to populations of these macaques may be at risk of infection with this zoonotic parasite.

# Plasmodium Parasites:

- The parasites are spread to people through **the bites of infected female Anopheles mosquitoes (vector)**.
- Which bite mainly between dusk and dawn.
- **Five** parasite species that cause malaria in humans
- **P. falciparum and P. vivax** pose the greatest threat.

- Other modes of transmission:
- From mother to unborn child
- Blood transfusion

# Plasmodium Parasites transmission and lifecycle:



# Incubation period

- Following the infective bite by the *Anopheles* mosquito, a period of time (the "incubation period") goes by before the first symptoms appear.
- The incubation period in most cases varies from 7 to 30 days. The shorter periods are observed most frequently with *P. falciparum* and the longer ones with *P. malariae*.
- Antimalarial drugs taken for prophylaxis by travelers can delay the appearance of malaria symptoms by weeks or months, long after the traveler has left the malaria-endemic area. (This can happen particularly with *P. vivax* and *P. ovale*, both of which can produce dormant liver stage parasites; the liver stages may reactivate and cause disease months after the infective mosquito bite.)
- Such long delays between exposure and development of symptoms can result in misdiagnosis or delayed diagnosis because of reduced clinical suspicion by the health-care provider. Returned travelers should always remind their health-care providers of any travel in areas where malaria occurs during the past 12 months.

# Symptoms

Infection with malaria parasites may result in a wide variety of symptoms, ranging from absent or very mild symptoms to severe disease and even death.

**Early symptoms**

Fever
Headache
Chills

**If not treated early might progress to**

**Severe illness**

Severe anemia
Respiratory distress
Cerebral malaria
Multiorgan failure

# Risk factors:

The most vulnerable are persons with **no or little immunity against the disease i**n areas with high transmission (such as Africa south of the Sahara).

- **Young children**, who have not yet developed partial immunity to malaria
- **Pregnant women**, whose immunity is decreased by pregnancy.
- **Travelers or migrants** coming from areas with little or no malaria transmission, who lack immunity.

# Immunity against malaria (protection)

- **Genetic Factors:** Biologic characteristics present from birth can protect against certain types of malaria: (having the **sickle cell trait**)
- **Acquired Immunity:** newborns in endemic areas will be protected during the first few months by maternal antibodies.
- **Repeated attacks of malaria**

# Control:

The main way to reduce malaria transmission at a community is **vector control**

- Insecticide-treated mosquito nets (ITNs)
- Indoor spraying with residual insecticides
- Antimalarial medications
- Vaccination

# Insecticide-treated mosquito nets (ITNs)

- For **all at-risk persons**
- Provision of free long lasting insecticide nets (LLINs)
- Everyone sleeps under a LLIN every night.
- Effective from 2-3 years

# Indoor spraying with residual insecticides

- **At least 80%** of houses in targeted areas are sprayed
- Protection depends on type of insecticide. Effective from 3-6 moths.

# Antimalarial medications

- To travelers
- Pregnant women
- Infants in endemic areas
- Seasonal chemoprevention

# Vaccine

- **Still under trial**

# Prevention And Control of malaria in KSA

The current elimination strategy in Saudi Arabia focuses mainly on:

1. Targeting **high risk areas** for sustained preventative measures such as (Long lasting insecticide treated nets, Indoor residual spraying)
2. **Management of infection** through rapid confirmed diagnosis and treatment.
3. Individual case follow up and reactive **surveillance** with appropriate treatment and vector control.
4. Active case detection **at borders** with screening and treatment.

- References:
- http://www.who.int/mediacentre/factsheets/fs094/en/.
- **http://www.cdc.gov/malaria/about/biology/human_factors.html**
- **World malaria report 2017, World Health Organization**