衞生防護中心
Centre for Health Protection

Update on Malaria: Epidemiology and Preventive Measures

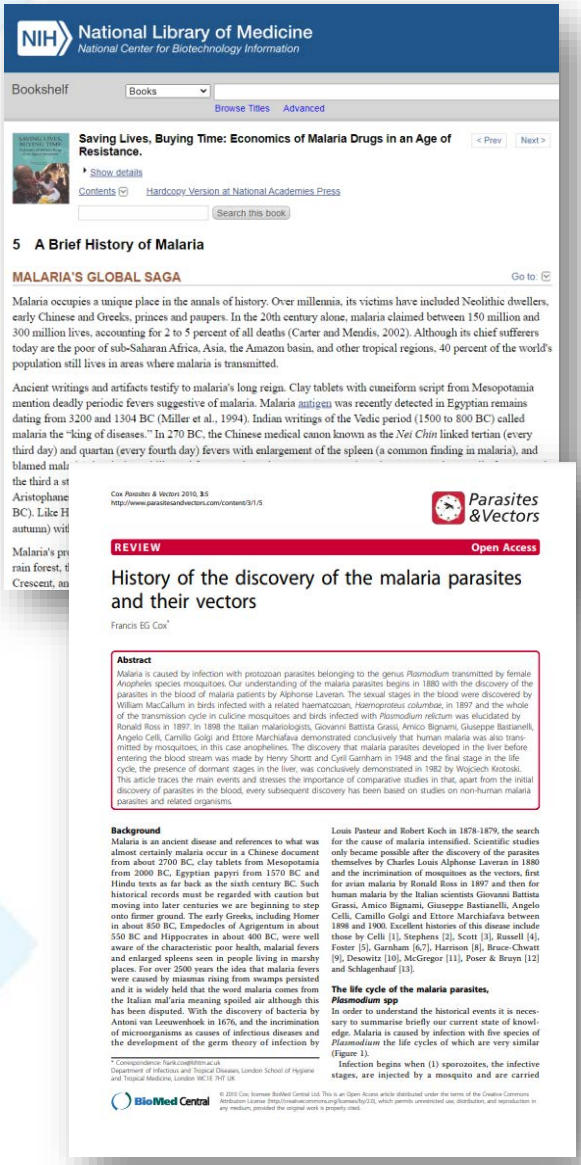
Surveillance Division
Communicable Disease Branch
Centre for Health Protection

23 August 2022

衞生署
Department of Health

Malaria - An Ancient Disease

- The term “malaria” was derived from the Italian for “bad air” (“mal’aria”) - a belief perpetuated by Roman physicians that the disease was caused by malignancies in swamp air
- Described first by the Chinese from 2700 B.C., found in clay tablets from Mesopotamia from 2000 B.C., Egyptian papyri from 1570 B.C. and Hindu texts as far back as the sixth century B.C.



National Library of Medicine
National Center for Biotechnology Information

Bookshelf Books
Browse Titles Advanced

Saving Lives, Buying Time: Economics of Malaria Drugs in an Age of Resistance.
Show details
Contents Hardcopy Version at National Academies Press
Search this book

5 A Brief History of Malaria

MALARIA'S GLOBAL SAGA

Malaria occupies a unique place in the annals of history. Over millennia, its victims have included Neolithic dwellers, early Chinese and Greeks, princes and paupers. In the 20th century alone, malaria claimed between 150 million and 300 million lives, accounting for 2 to 5 percent of all deaths (Carter and Mendis, 2002). Although its chief sufferers today are the poor of sub-Saharan Africa, Asia, the Amazon basin, and other tropical regions, 40 percent of the world's population still lives in areas where malaria is transmitted.

Ancient writings and artifacts testify to malaria's long reign. Clay tablets with cuneiform script from Mesopotamia mention deadly periodic fevers suggestive of malaria. Malaria antigen was recently detected in Egyptian remains dating from 3200 and 1304 BC (Miller et al., 1994). Indian writings of the Vedic period (1500 to 800 BC) called malaria the “king of diseases.” In 270 BC, the Chinese medical canon known as the *Nei Chin* linked tertian (every third day) and quartan (every fourth day) fevers with enlargement of the spleen (a common finding in malaria), and

Parasites & Vectors

REVIEW Open Access

History of the discovery of the malaria parasites and their vectors

Francis EG Cox*

Abstract

Malaria is caused by infection with protozoan parasites belonging to the genus *Plasmodium* transmitted by female *Anopheles* species mosquitoes. Our understanding of the malaria parasites begins in 1880 with the discovery of the parasites in the blood of malaria patients by Alphonse Laveran. The sexual stages in the blood were discovered by William MacCallum in birds infected with a related haematozoan, *Haemoproteus columbae*, in 1897 and the whole of the transmission cycle in culicine mosquitoes and birds infected with *Plasmodium relictum* was elucidated by Ronald Ross in 1897. In 1898 the Italian malariologists, Giovanni Battista Grassi, Amico Bignami, Giuseppe Bastianelli, Angelo Celli, Camillo Golgi and Ettore Marchiafava demonstrated conclusively that human malaria was also transmitted by mosquitoes, in this case anophelines. The discovery that malaria parasites developed in the liver before entering the blood stream was made by Henry Shortt and Cyril Garnham in 1948 and the final stage in the life cycle, the presence of dormant stages in the liver, was conclusively demonstrated in 1982 by Wojciech Krotoski. This article traces the main events and stresses the importance of comparative studies in that, apart from the initial discovery of parasites in the blood, every subsequent discovery has been based on studies on non-human malaria parasites and related organisms.

Background

Malaria is an ancient disease and references to what was almost certainly malaria occur in a Chinese document from about 2700 BC, clay tablets from Mesopotamia from 2000 BC, Egyptian papyri from 1570 BC and Hindu texts as far back as the sixth century BC. Such historical records must be regarded with caution but moving into later centuries we are beginning to step onto firmer ground. The early Greeks, including Homer in about 850 BC, Empedocles of Agrigentum in about 550 BC and Hippocrates in about 400 BC, were well aware of the characteristic poor health, malarial fevers and enlarged spleens seen in people living in marshy places. For over 2500 years the idea that malaria fevers were caused by miasmas rising from swamps persisted and it is widely held that the word malaria comes from the Italian mal'aria meaning spoiled air although this has been disputed. With the discovery of bacteria by Antoni van Leeuwenhoek in 1676, and the incrimination of microorganisms as causes of infectious diseases and the development of the germ theory of infection by Louis Pasteur and Robert Koch in 1878-1879, the search for the cause of malaria intensified. Scientific studies only became possible after the discovery of the parasites themselves by Charles Louis Alphonse Laveran in 1880 and the incrimination of mosquitoes as the vectors, first for avian malaria by Ronald Ross in 1897 and then for human malaria by the Italian scientists Giovanni Battista Grassi, Amico Bignami, Giuseppe Bastianelli, Angelo Celli, Camillo Golgi and Ettore Marchiafava between 1898 and 1900. Excellent histories of this disease include those by Celli [1], Stephens [2], Scott [3], Russell [4], Foster [5], Garnham [6,7], Harrison [8], Bruce-Chwatt [9], Desowitz [10], McGregor [11], Poser & Bruyn [12] and Schlagenhauf [13].

The life cycle of the malaria parasites, *Plasmodium* spp

In order to understand the historical events it is necessary to summarise briefly our current state of knowledge. Malaria is caused by infection with five species of *Plasmodium* the life cycles of which are very similar (Figure 1).

Infection begins when (1) sporozoites, the infective stages, are injected by a mosquito and are carried

* Correspondence: frank.cox@lshtm.ac.uk
Department of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine, London WC1E 7HT UK

BioMed Central

© 2010 Cox; licensee BioMed Central Ltd. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Source:
https://parasitesandvectors.biomedcentral.com/articles/10.1186/1756-3305-3-5
https://www.ncbi.nlm.nih.gov/books/NBK215638

Malaria – Discovery of Parasite

- In 1880, Charles Louis Alphonse Laveran (French army doctor) discovered the parasite in the blood of a malaria patient while stationed in Algeria
- In August 1897, Sir Ronald Ross (a British medical doctor) found the malaria parasite while dissecting the stomach tissue of an anopheline mosquito fed 4 days previously on a malarious patient and went on to prove the role of Anopheles mosquitoes in the transmission

Source:
https://www.cdc.gov/malaria/about/history/laveran.html
https://www.cdc.gov/malaria/about/history/ross.html

The Disease

- Causative agent (*Plasmodium* parasites)
  - 5 species that can cause malaria in humans, namely *P. falciparum*, *P. vivax*, *P. malariae*, *P. ovale* and *P. knowlesi*
  - *P. falciparum* causes most deaths and is most prevalent in Africa
  - *P. vivax* dominant in most countries outside sub-Saharan Africa
- Clinical features
  - Symptoms include fever, chills, headache, muscle pain and weakness, cough, vomiting, diarrhea and abdominal pain
  - Differential diagnosis of PUO
  - Complications include anaemia, generalized convulsion, shock, organ failure (e.g. renal failure), coma
  - Untreated *P. falciparum* malaria can progress to severe illness and death within 24 hours

The Disease

- Mode of transmission
  - Vector-borne (infected female *Anopheles* mosquitoes)
  - Transfusion of contaminated blood products, organ transplant, shared needles or syringes
  - Vertical transmission
- Incubation period
  - Varies between *Plasmodium* species
  - Usually ranges from 7 to 30 days (can be months or longer)
  - *P. vivax* and *P. ovale* can relapse as hypozoites can remain dormant in the liver for several months up to 4 years after infection
- Case fatality rate
  - *P. falciparum*: 0.01% -0.40%
  - *P. vivax*: 0.01%-0.06%

Global Situation

World Health Organization

Health Topics | Countries | Newsroom | Emergencies | Data | About WHO

THE GLOBAL HEALTH OBSERVATORY

Explore a world of health data

Indicators | Countries

GHO Home | Indicators | Countries | Data API | Map Gallery | Publications | Data Search

Data / GHO / Themes

Malaria

Malaria transmission occurs in 85 countries across five WHO regions. Since 2015, the WHO European Region has been free of malaria.

According to the World Malaria Report 2020, there were 241 million cases of malaria globally in 2020 (uncertainty range 218–269 million) and 627 000 malaria deaths (uncertainty range 583–765 thousand). Malaria case incidence reduced from 81 in 2000 to 59 in 2015 and 56 in 2019, before increasing again to 59 in 2020. Globally, malaria deaths reduced steadily over the period 2000–2019, from 896 000 in 2000 to 562 000 in 2015 and to 558 000 in 2019. In 2020, malaria deaths increased by 12% compared with 2019. The increases in malaria cases are deaths were associated with disruption to services during the COVID-19 pandemic.

Malaria burden was heaviest in the WHO African Region, with an estimated 95% of cases and 96% of deaths; 80% of all deaths in this region are among children aged under 5 years.

Cases

241 million

estimated malaria cases in 85 malaria endemic countries in 2020

Incidence

5%

global increase in malaria incidence between 2019 and 2020 due to service disruptions during the COVID-19 pandemic

Mortality

12%

global increase in estimated malaria deaths between 2019 and 2020;

Deaths

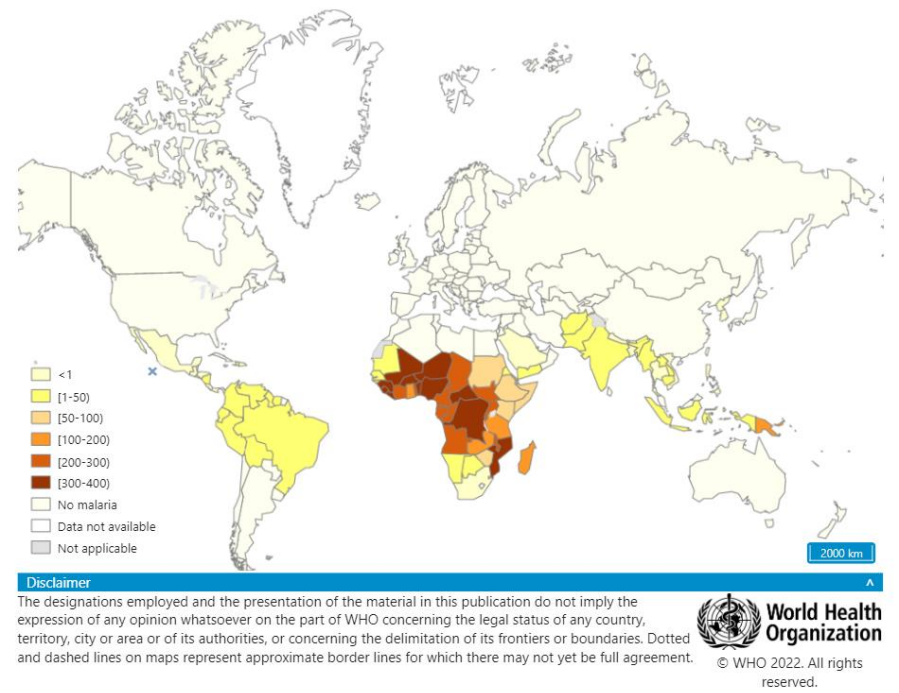
47 000

additional deaths in 2020 were due to service disruptions during the COVID-19 pandemic

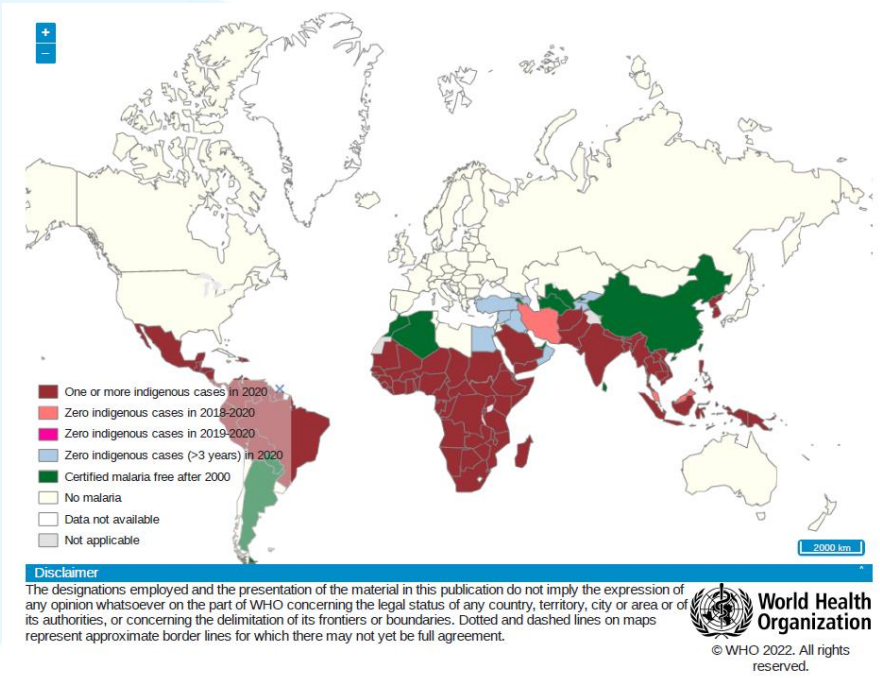
Source: https://www.who.int/data/gho/data/themes/malaria

Global Situation

Estimated incidence (per 1000 population at risk)



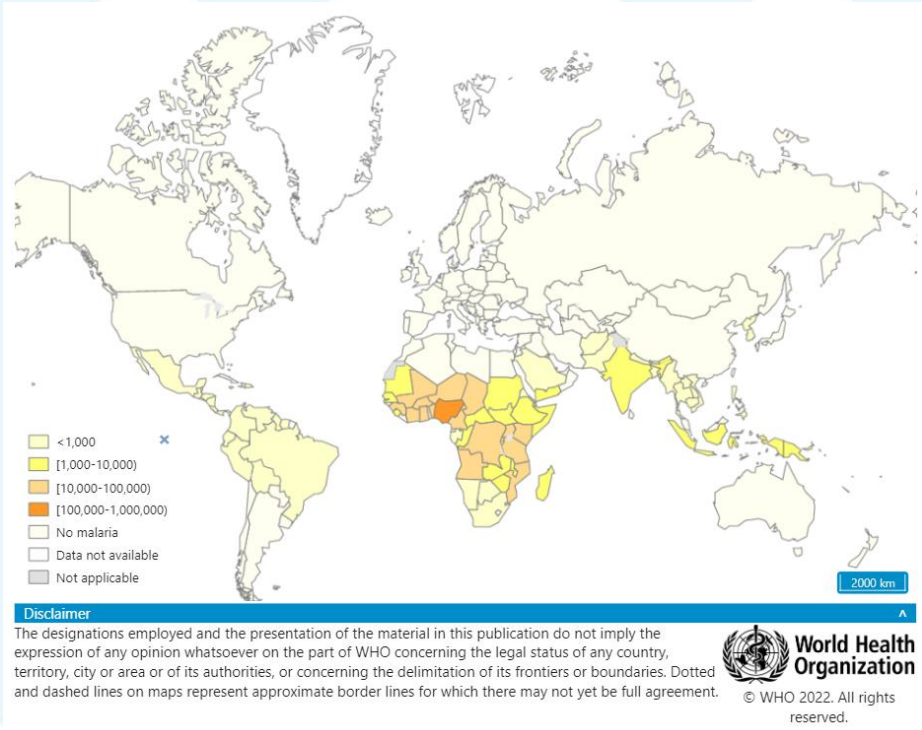
Status of indigenous malaria cases



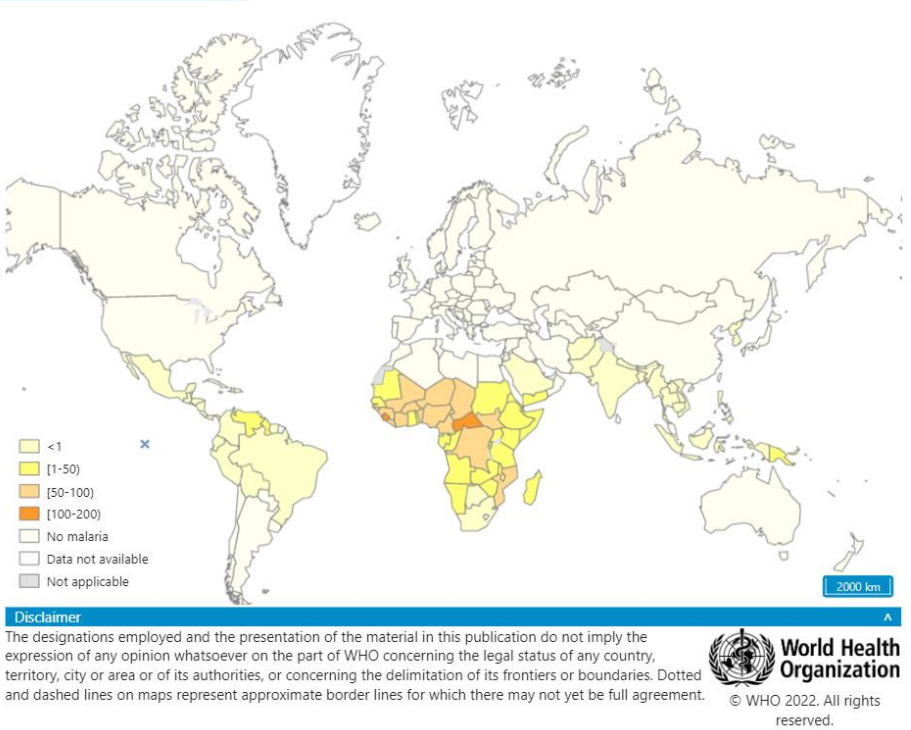
Source:
https://www.who.int/data/gho/data/indicators/indicator-details/GHO/number-of-indigenous-malaria-cases
https://www.who.int/data/gho/data/indicators/indicator-details/GHO/malaria-incidence-(per-1-000-population-at-risk)

Global Situation

Estimated No. of deaths



Estimated mortality per 100,000 population



Source:
https://www.who.int/data/gho/data/indicators/indicator-details/GHO/estimated-number-of-malaria-deaths
https://www.who.int/data/gho/data/indicators/indicator-details/GHO/estimated-malaria-mortality-rate-per-100-000-population

衞生署 Department of Health

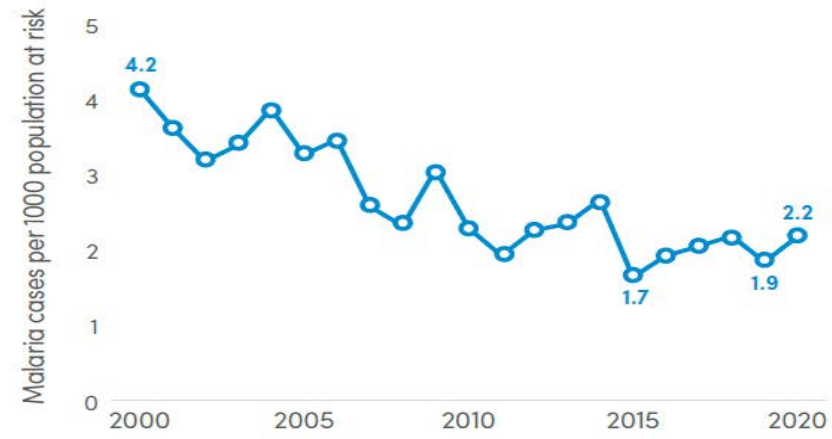
Global Situation

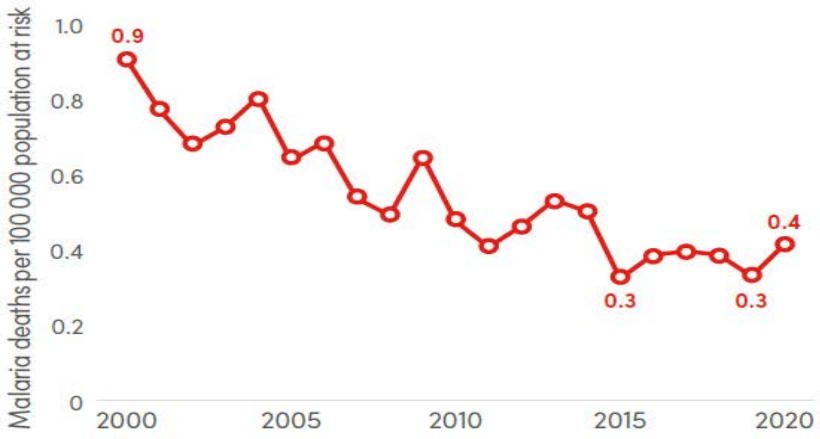
- WHO African Region continues to carry the highest share of the global malaria burden – 95% of all cases, 96% of deaths
- 241 million cases of malaria in 2020 compared to 227 million cases in 2019 (↑6.2%)
- Estimated number of malaria deaths: 627 000 in 2020 compared to 558 000 in 2019 (↑12.4%)
  - About 2/3 of additional deaths (47 000) were due to service disruptions (e.g. malaria prevention services like distribution of insecticide-treated bed nets / indoor residual spraying, diagnosis and treatment services like malaria testing, etc.), particularly in sub-Saharan Africa, during the COVID-19 pandemic.
- Four African countries accounted for over half of all malaria deaths worldwide – **Nigeria** (31.9%), **the Democratic Republic of the Congo** (13.2%), **United Republic of Tanzania** (4.1%) and **Mozambique** (3.8%)

Source: WHO World Malaria Report 2021

Situation in Western Pacific

- 2000-2019, cases decreased from an estimated 2.8M to 1.4M (↓ 49%), and deaths from 6100 to 2600 (↓ 57%)
- Between 2019 and 2020
  - Cases from 1.4M to 1.7M (↑19%); deaths from 2600 to 3200 (↑23%)
  - Increases mainly contributed by Papua New Guinea
- Mainland China has had no indigenous malaria cases since 2017 and was certified malaria free in 2021





Source: WHO World Malaria Report 2021

Local Situation

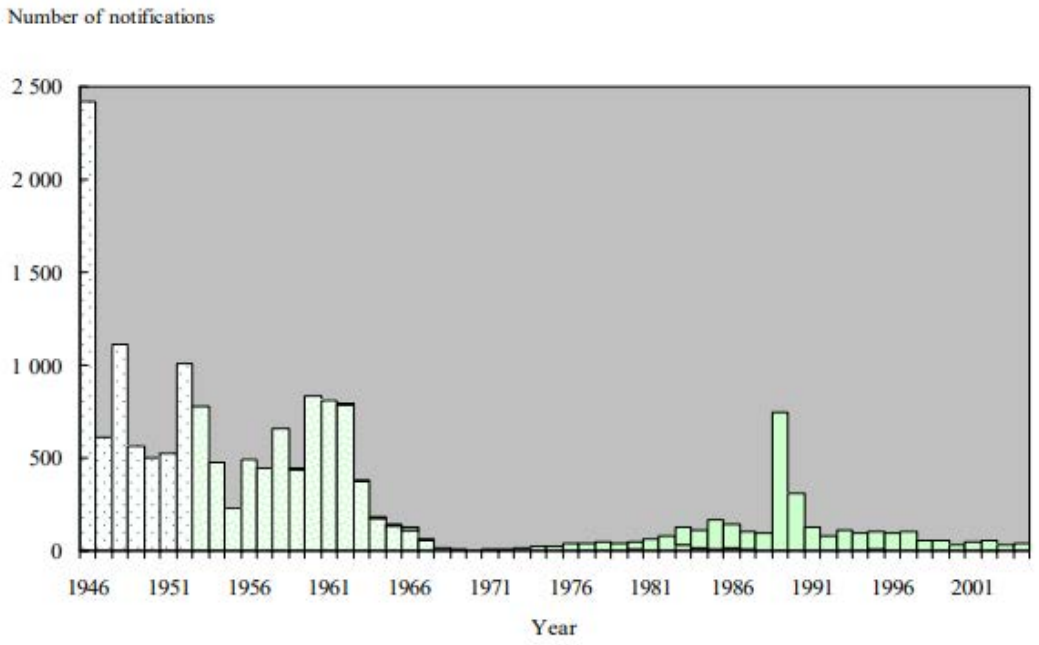
- Endemic in Hong Kong in the 19th century with high fatality
- Record high of 2 422 cases in 1946, then decreased to < 400
- Shift from locally-acquired to imported infections since 1970s
- Local *P. vivax* outbreak in Sai Kung in 1983 with 19 cases
- Brief upsurge to >700 cases related to Vietnamese migrants in 1989

14.1.1 History of Malaria in Hong Kong (1)

Before the Second World War, malaria was rampant in Hong Kong. A Malaria Bureau was established in 1930 in the Department of Health headed by a Government Malariologist.

Even in the early period after the end of the Second World War, malaria accounted for a substantial part of the morbidity and mortality. In 1946, out of an estimated population of 1.5 million, there was in that year over 2,400 cases with 765 deaths, giving an incidence rate of 1.6 cases per 1,000 population and a case fatality rate of 31.6%.

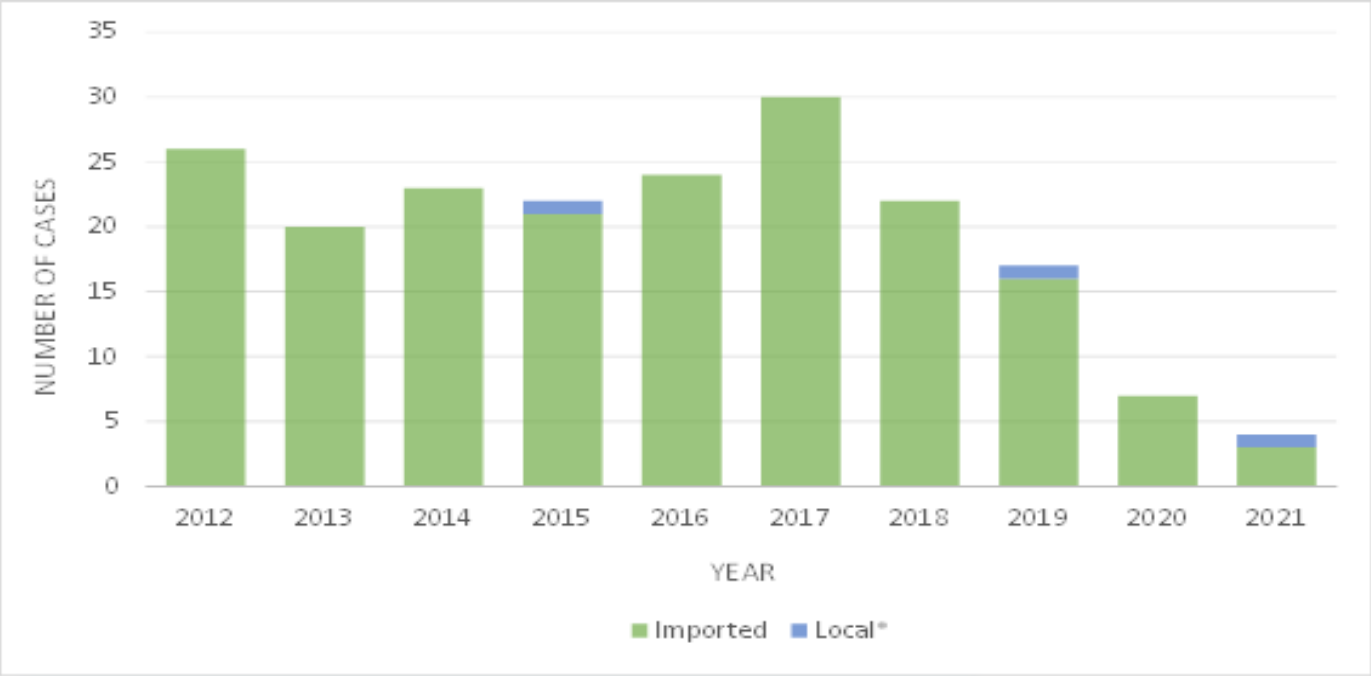
From late 1960s to early 1970s there was a significant drop in the number of malaria cases. It was the lowest on record averaging 10 cases a year. From 1969 to 1976, there was not one single indigenous case reported for a successive period of 8 years. The successful control of malaria also saw the disbanding of the Malaria Bureau in 1966 and the absorption of the staff and the anti-malaria work into the Urban Services Department.



Source: Lee SH. Epidemiological Surveillance of Communicable Disease in Hong Kong. 1991.

Local Situation 2012-21

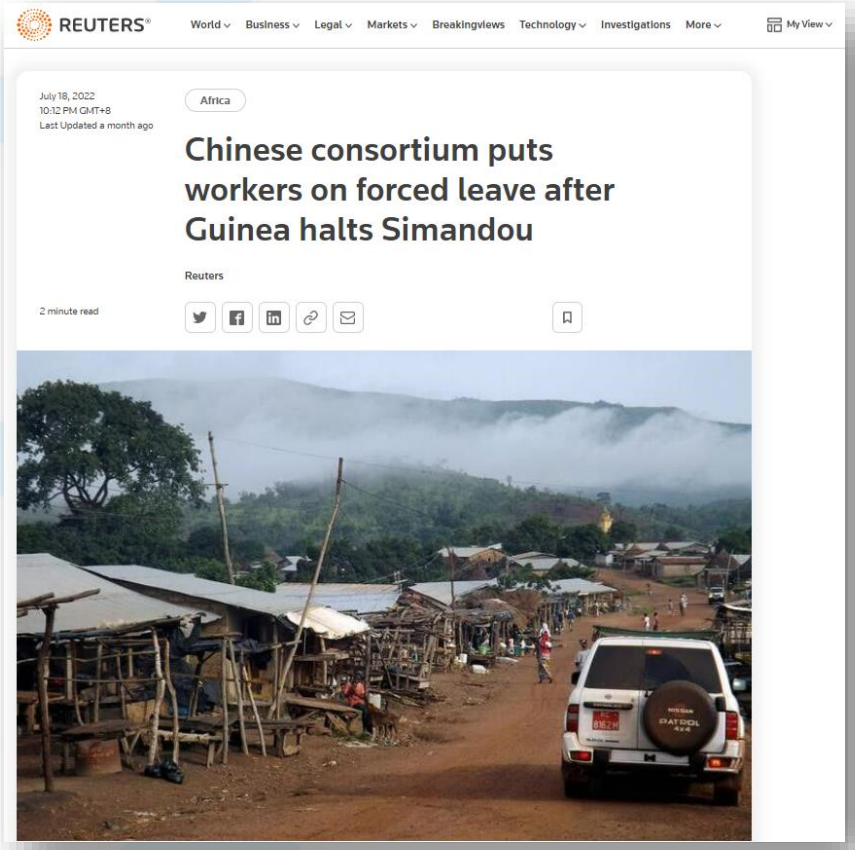
- Last local indigenous case was recorded in 1998
- Past 10 years (2012 – 2021)
  - 195 cases recorded (Annual number 4-30)
  - 3 cases recrudescence from past subclinical infection of *P. malariae*
  - All remaining cases were imported from endemic countries including India (22%), Nigeria (17%) and Pakistan (11%)



* All 3 cases are due to recrudescence

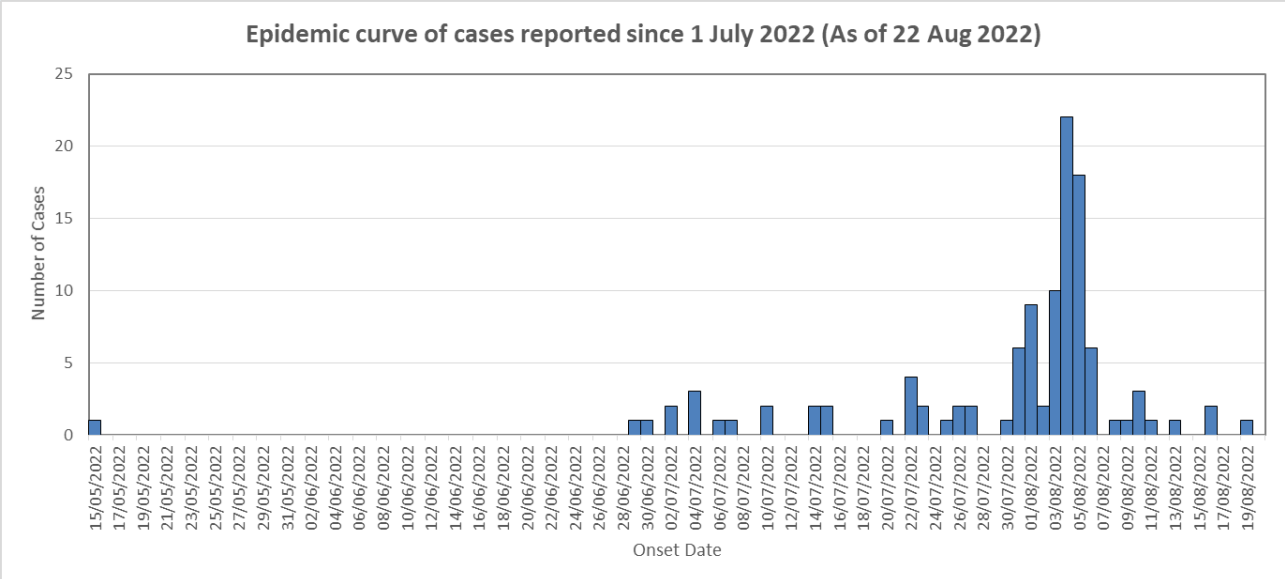
Local Situation in 2022

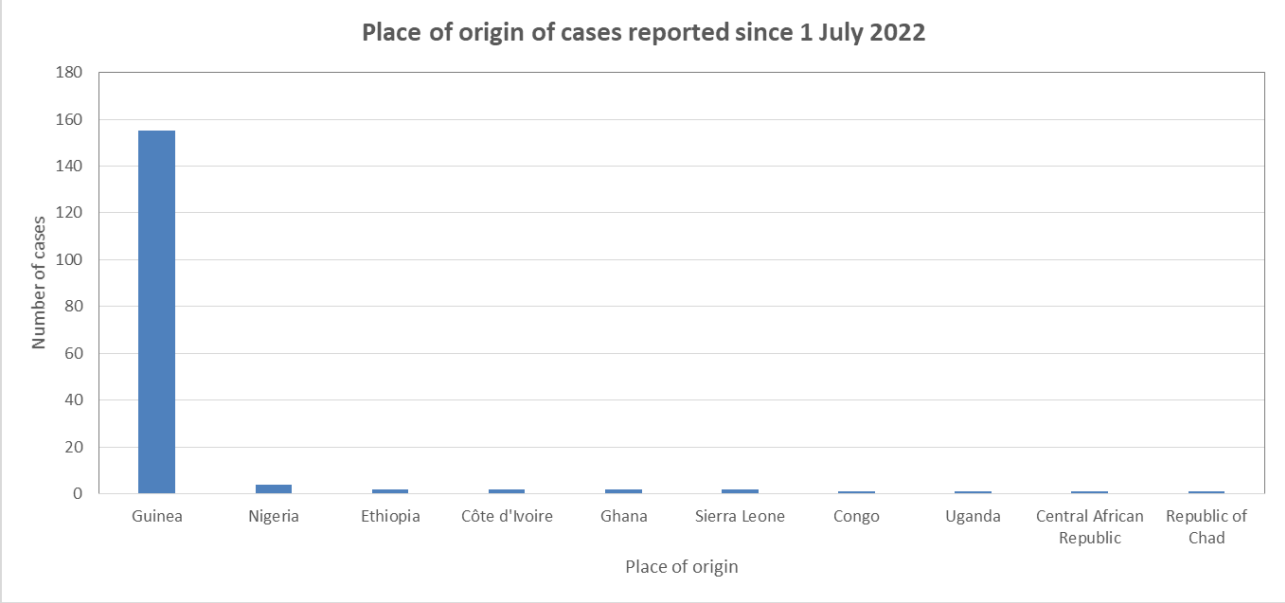
- From 1 July to 22 August, 171 cases were recorded
  - All imported
  - 169 males and 2 females, aged 23 to 61; all were Chinese
  - 155 arrived from Guinea, the remaining 16 arrived from other African countries
  - Majority (~85%) were working as railway/construction workers
  - 2 fatal cases (male aged 52 & 53)



Source: https://www.reuters.com/world/africa/chinese-consortium-puts-workers-forced-leave-after-guinea-halts-simandou-2022-07-18/

Local Situation in 2022





Public Health Measures Taken

- Port Health measures
- Active screening
- Case isolation in HA hospitals
- Treatment of cases
- Epidemiological investigation
- Vector control
- Risk communication
  - Press release
  - Letter to doctors
  - Health promotion
- Notification to Mainland and Macao

瘧疾襲港｜謝展寰視察食環署防治蚊患措施 籲市民起居上防止蚊蟲滋生

2022年08月07日 06:43

本港近日錄得多宗外地輸入的瘧疾個案，政府對此十分關注。環境及生態局局長謝展寰今日（7日）到葵涌瑪嘉烈醫院附近山坡實地視察食環署的防治蚊患措施，並呼籲市民一同在家居及其他環境採取防蚊及滅蚊措施，防患於未然。

https://www.singtao.ca/5951951/2022-08-07/news-瘧疾襲港｜謝展寰視察食環署防治蚊患措施+籲市民起居上防止蚊蟲滋生

Prevention at the Individual Level

Prevention of mosquito bite

- Wear loose, light-coloured, long-sleeved tops and trousers
- Use DEET-containing insect repellent on exposed parts of the body and clothing
- When engaging in outdoor activities, avoid using fragrant cosmetics or skin care products and re-apply insect repellents according to instructions

Prevention of mosquito proliferation

- Prevent accumulation of stagnant water
- Control vectors and reservoir of the diseases (e.g. proper storage and disposal of garbage)

Prevention at the Individual Level

Travel health advice

- Take measures to avoid mosquito bites
  - Children ≥ 2 months can use DEET-containing insect repellents with concentration of DEET up to 30%
  - In endemic rural areas, carry a permethrin-treated portable bed net
- Chemoprophylaxis
  - Prescribed depending on the itinerary, time of travel, types of activities and past medical history of the traveler
  - Start before the trip up until a period of time after leaving the area
- Vaccination
  - Not applicable for travellers to malaria-endemic regions
- Pregnant women should not visit endemic regions unless absolutely necessary
- Seek urgent medical attention if experiencing symptoms of malaria during or after travel

Global Malaria Risk Summary

- The Scientific Committee on Vector-borne Diseases (SCVBD) under the CHP compiled the first “Global Malaria Risk Summary” in 2007, which has been updated regularly every 2-3 years
- The Summary document describes the malaria risk of endemic countries and areas for reference by healthcare professionals
- Latest update in May 2022 highlights the major changes in the global epidemiology and risk of malaria from October 2019 to May 2022
- It is compiled based on epidemiological information and malaria prevention measures recommended by the WHO, CDC of the US, PHAC of Canada, as well as PHE and NaTHNaC of UK

Global Malaria Risk Summary

Risk Category	Risk Description	Recommendation Category	Recommendation Description
1	**No malaria risk** (as reported by WHO, CDC, PHAC and PHE)	I	General precaution during travel
2	**Malaria risk reported to be very limited**	II	Malaria prevention may be required ➢ Advise to undertake mosquito bite prevention ➢ Obtain update on latest epidemiology
3	**Risk of chloroquine-sensitive malaria only** **3A**: Risk of malaria exists in the whole administrative area **3B**: Risk of malaria exists in certain areas	III	Malaria prevention recommended ➢ Advise to undertake mosquito bite prevention ➢ When travelling to at-risk areas, consider chemoprophylaxis using chloroquine
4	**Chloroquine-resistant malaria have been reported** **4A**: Risk of malaria exists in the whole administrative area **4B**: Risk of malaria exists in certain areas	IV	Malaria prevention recommended ➢ Advise to undertake mosquito bite prevention ➢ When travelling to areas at risk of chloroquine-resistant malaria, consider chemoprophylaxis using atovaquone/proguanil, doxycycline, or mefloquine ➢ When travelling to areas at risk of chloroquine-sensitive malaria, consider chemoprophylaxis using chloroquine
5	**Malaria resistant to both chloroquine and mefloquine have been reported** **5A**: Risk of malaria exists in the whole administrative area **5B**: Risk of malaria exists in certain areas	V	Malaria prevention recommended ➢ Advise to undertake mosquito bite prevention ➢ When travelling to areas at risk of mefloquine-resistant malaria, consider chemoprophylaxis using atovaquone/proguanil or doxycycline, BUT NOT mefloquine ➢ When travelling to areas at risk of chloroquine-resistant malaria, consider chemoprophylaxis using atovaquone/proguanil, doxycycline, or mefloquine

Global Malaria Risk Summary

Table 1: Risk categories of countries and areas in the six WHO Regions

Region	1	2	3A	3B	4A	4B	5A	5B	Total
African	4	1	0	0	34	9	0	0	48
The Americas	28	2	1	5	1	8	0	1	46
Eastern Mediterranean	9	4	0	0	3	5	0	0	21
European	48	5	0	0	0	0	0	0	53
South-East Asia	2	1	0	0	1	5	0	2	11
Western Pacific	24	2	0	0	2	3	0	3	34
Total	115	15	1	5	41	30	0	6	**213**

Table 2: Recommendation categories of countries and areas in the six WHO Regions

Region	I	II	III	IV	V	Total
African	4	1	0	43	0	48
The Americas	28	2	6	9	1	46
Eastern Mediterranean	9	4	0	8	0	21
European	48	5	0	0	0	53
South-East Asia	2	1	0	6	2	11
Western Pacific	24	2	0	5	3	34
Total	115	15	6	71	6	**213**

https://www.chp.gov.hk/files/pdf/global_malaria_risk_summary_2022.pdf

End of Presentation

Thank you!