

Malaria resurgence: A Case study of Sistan & Balouchetsan Province



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Trends in the burden of malaria

- Globally in 2022, there were an estimated 249 million malaria cases in 85 malaria endemic countries
- An increase of 5 million cases compared with 2021.
- The main countries contributing to the increase were Pakistan (+2.1 million), Ethiopia (+1.3 million), Nigeria (+1.3 million), Uganda (+597 000) and Papua New Guinea (+423 000).
- In 2022, malaria case incidence was 58 per 1000 population at risk.
- The proportion of cases due to *P. vivax* decreased from about 8% in 2000 to 3% in 2022.

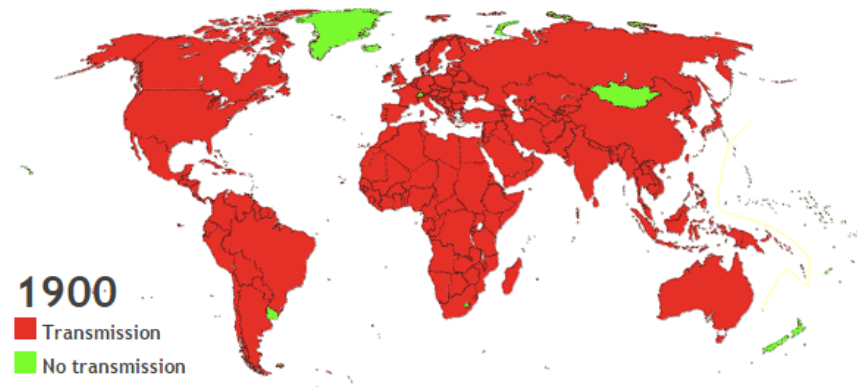
Key events in 2022–2023

- In the WHO **Eastern Mediterranean Region**, malaria cases **decreased** by **38%**, from about 7 million cases in 2000 to about **4 million** in **2015**. Between **2015** and **2022**, cases rose by **92%** to **8.3** million.
- Global malaria **progress has stalled** in recent years, and a “**business as usual**” approach will take countries and their development partners further **off course**.
- Recognizing that **getting back on track** will require major changes in the malaria response.

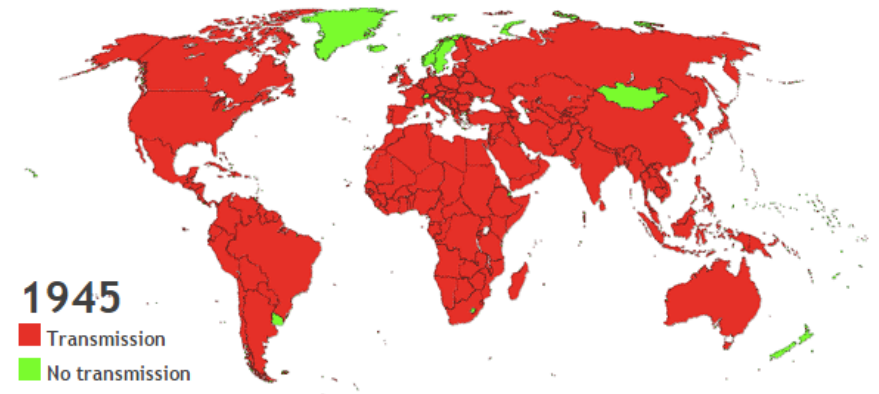
History of Malaria Control: Renewed Global Commitment

- Malaria reemerged as a major international health issue in the 1990s
- In 1955, the World Health Assembly launched a malaria eradication campaign based largely on the use of DDT.
- In 1969, the WHO officially abandoned the eradication program in favor of a control program based on case management.
- Global malaria control strategy adopted in 1992.
- Roll Back Malaria was launched in 1998 bringing together multilateral, bilateral, nongovernmental, and private organizations. It made a clear pledge—to halve deaths from malaria by 2010.

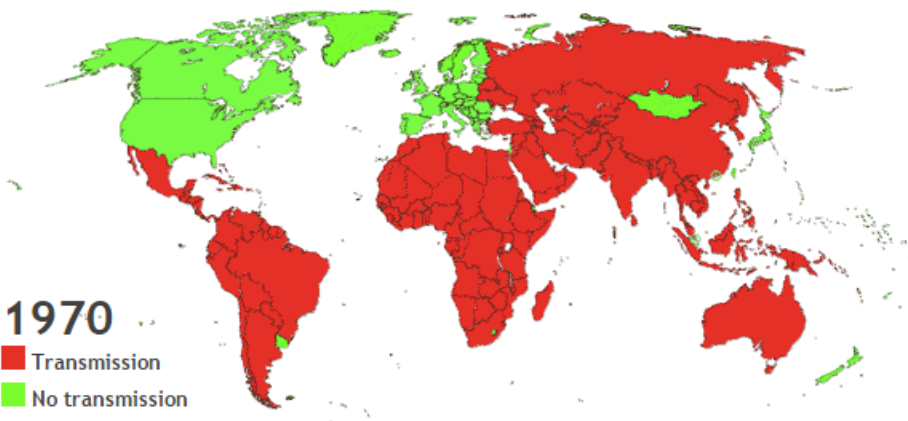
Boundaries of Malaria Transmission By Country



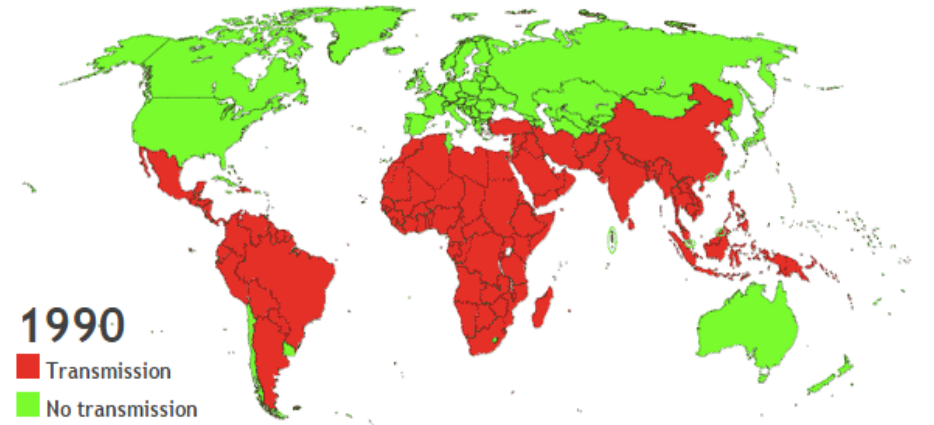
Boundaries of Malaria Transmission By Country



Boundaries of Malaria Transmission By Country



Boundaries of Malaria Transmission By Country



Malaria elimination certification

- A country or area is granted certification once it has been proven, **beyond a reasonable doubt**, that:
- The **chain of mosquito-borne transmission** has been **interrupted nationwide**, resulting in **zero indigenous malaria cases** for at least **the past 3 consecutive years**.
- Additionally, there must be a programme in place for **preventing the re-establishment** of transmission.

Malaria elimination and prevention of re-establishment

- Between 2000 and 2022, 25 countries that were malaria endemic in 2000 have achieved 3 consecutive years of zero indigenous malaria cases.
- Twelve of these countries were certified malaria free by WHO.
- No countries were certified malaria free in 2022.
- Three countries – Azerbaijan, Belize and Tajikistan were granted certification in 2023.

The "2nd Annual Global Forum of Malaria-Eliminating Countries",
San Jose, Costa Rica, 11-13 June 2018



Malaria elimination and prevention of re-establishment

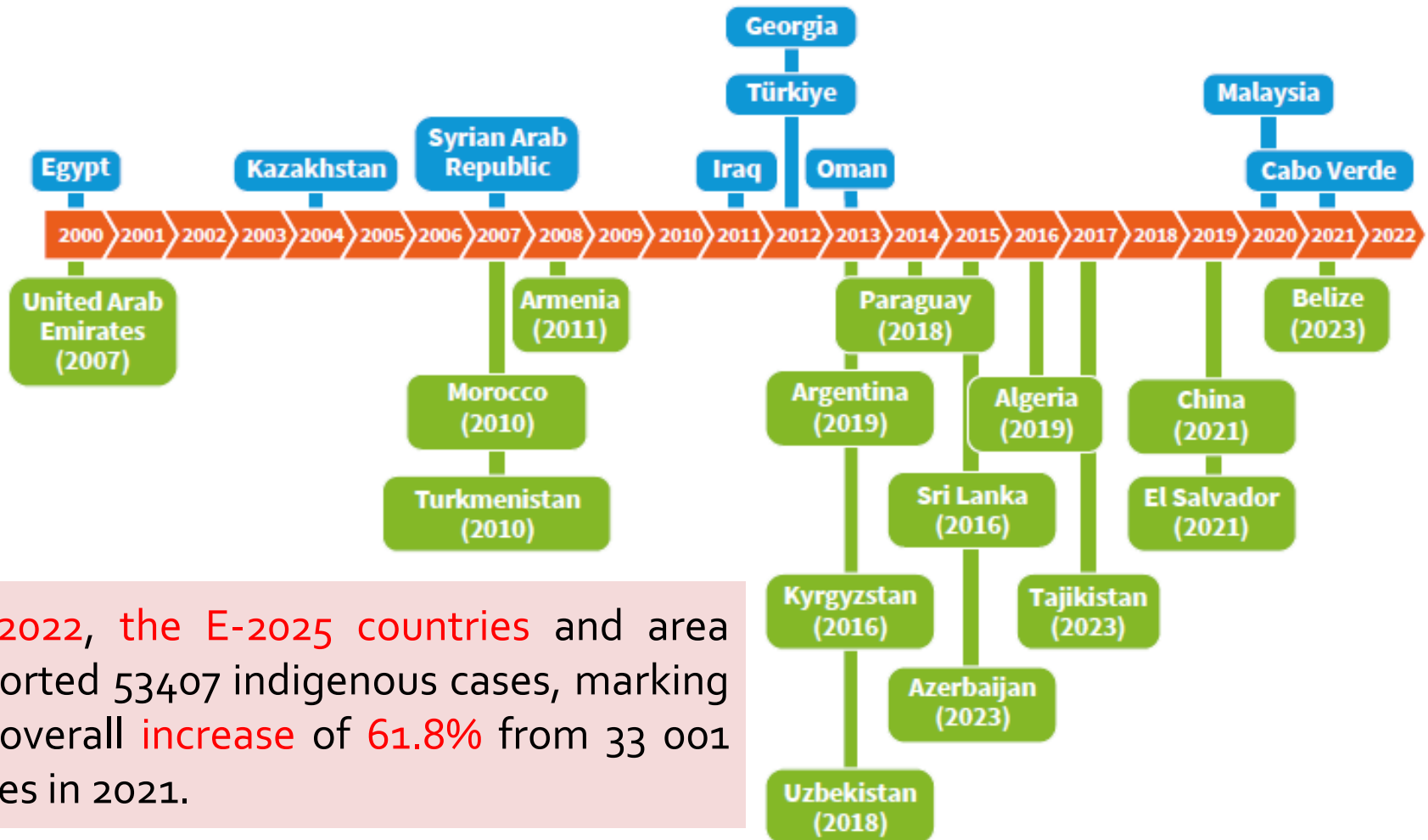
- There was a resurgence of cases in the Islamic Republic of Iran in 2022, with 1439 locally acquired cases reported in 2022 after 4 consecutive years of zero indigenous cases.

E-2025 initiative

- The malaria eliminating countries for 2025 (**E-2025**) initiative, launched in **2021**, succeeded the **E-2020 initiative**.
- E-2025 includes 25 countries and one area including: the **Islamic Republic of Iran** and **Saudi Arabia**.
- The selection of the E-2025 countries was based on criteria such as:
 - having a **government-endorsed elimination plan**
 - meeting a defined threshold of **malaria case reductions** in recent years
 - meeting pre-defined programme requirements
 - expert opinions (including from WHO)

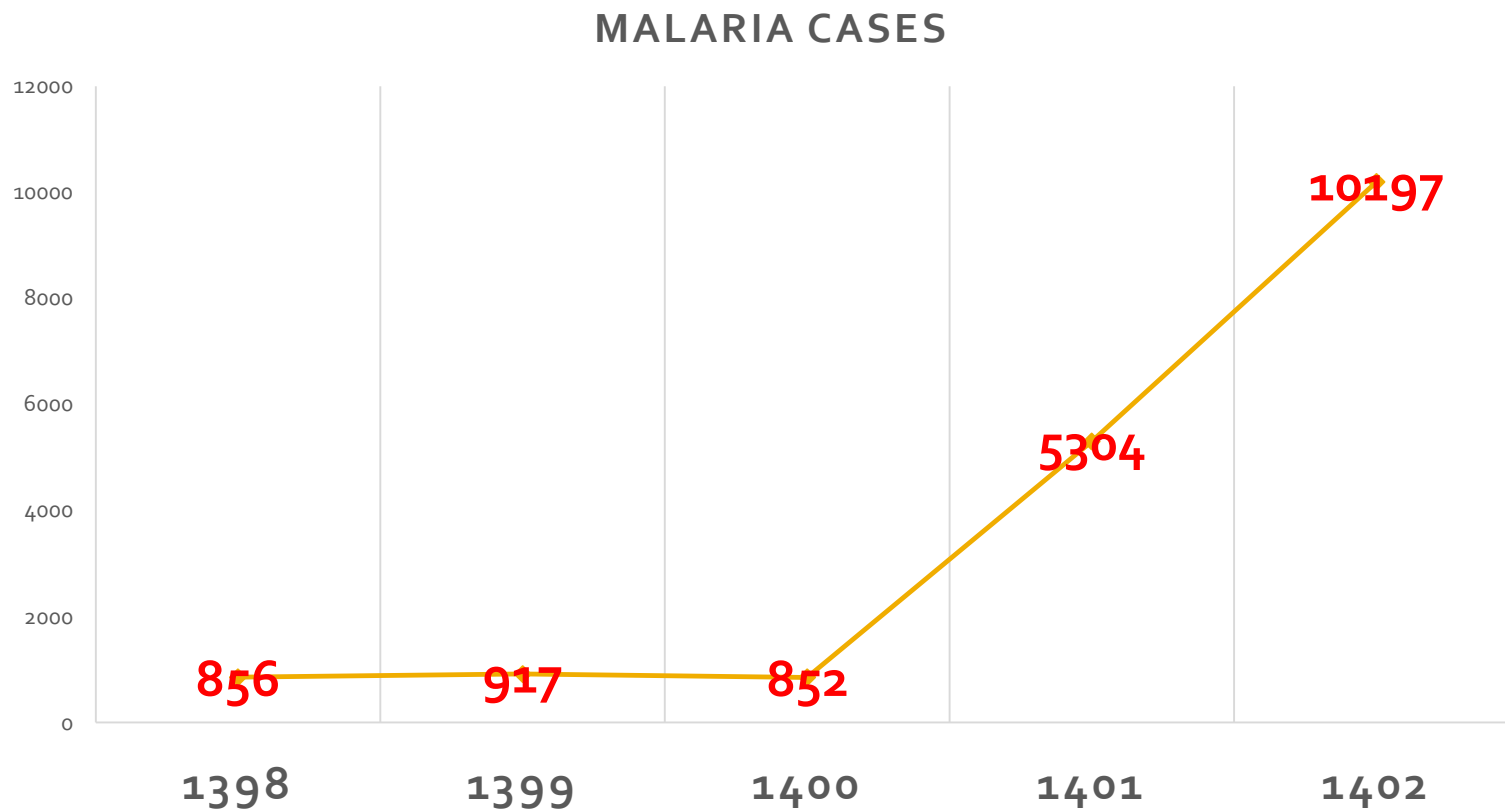
Countries eliminating malaria since 2000

Sources: Country reports and WHO

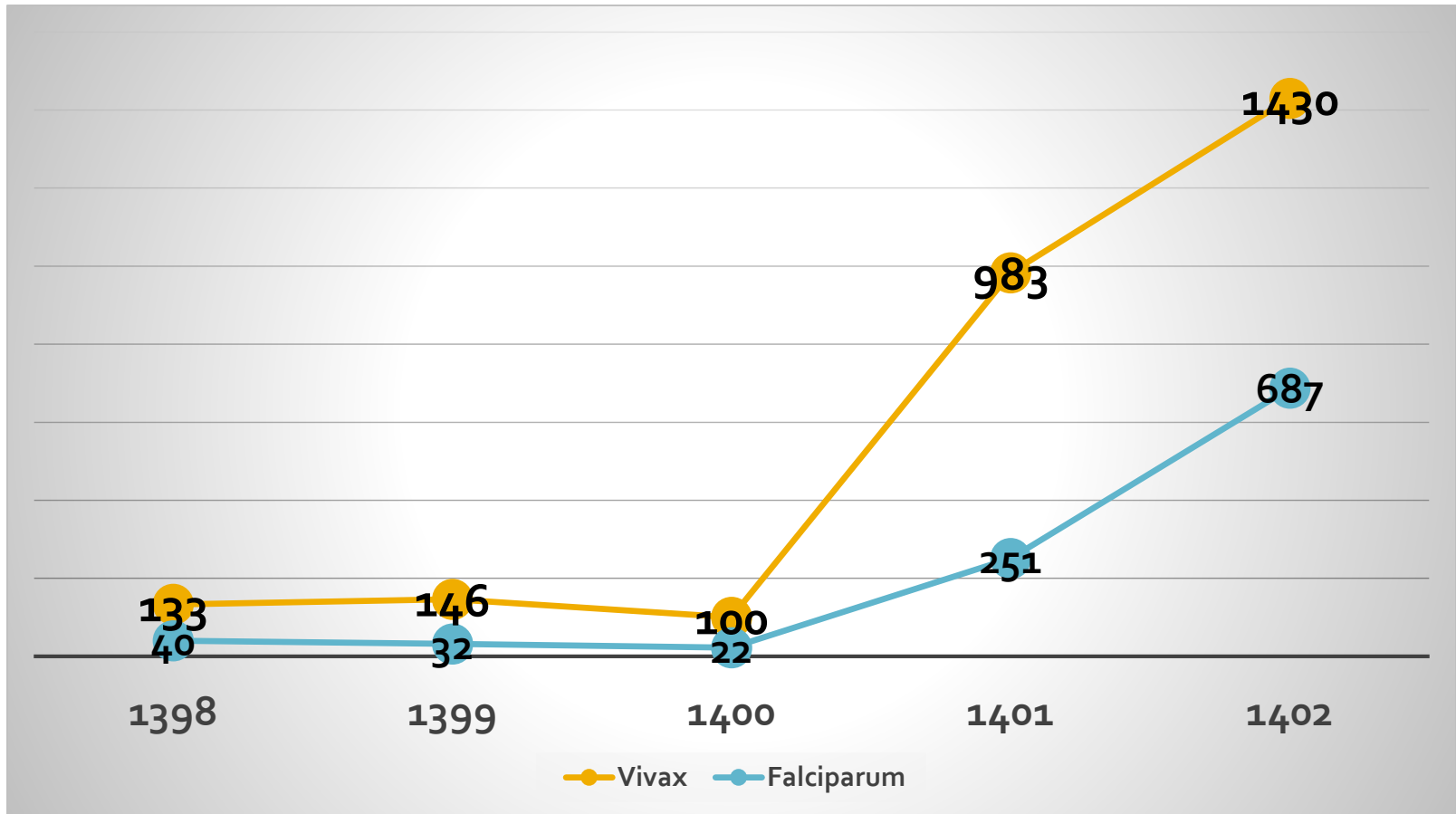


In 2022, the E-2025 countries and area reported 53407 indigenous cases, marking an overall increase of 61.8% from 33 001 cases in 2021.

The Trend of Malaria in Sistan & Balouchestan Province-1398-1402



The Trend of Malaria Cases in ZAUMS by Plasmodium species-1398-1402



Changes in the malaria trend in ZAUMS as compared to last year

- **75.5%** increase in malaria cases
- **90%** increase expected by the end of this year
- **184%** increase in **falciparum malaria** (**31%** of malaria cases)
- **80%** increase in cases among **Iranian population**
- **۲۹۵%** increase in cases among **military forces** stationed in the border areas
- **۱۳۴%** increase in **hospitalizations** of identified cases
- Increasing **the number of habitats** for the larvae of malaria vectors
- Increasing **the abundance** of malaria vectors and in addition increasing **the lifespan of the vector**

The major Challenges to Malaria Elimination program

- The **long common porous border** with neighboring countries (1580 km) and resulting cross border population movements
- Establishment of **Fuel Markets** at zero border points (Mok Sokhte, Kalegan, Shamsar, Sarklukian, Pirkor, etc.)
- **Non-Iranian nationals** living in the villages and outskirts of the cities of Saravan, Soran, Zahedan, Khash
- **Human trafficking** from the border of Saravan

The major Challenges to Malaria Elimination program

- The interruption of elimination measures caused by COVID-19 Pandemic
- Severe reduction in budget allocation for malaria elimination program
- Decreased field visits

Malaria resurgence

Cohen et al. *Malaria Journal* 2012, **11**:122
<http://www.malariajournal.com/content/11/1/122>



RESEARCH

Open Access

Malaria resurgence: a systematic review and assessment of its causes

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Abstract

Background: Considerable declines in malaria have accompanied increased funding for control since the year 2000, but historical failures to maintain gains against the disease underscore the fragility of these successes. Although malaria transmission can be suppressed by effective control measures, in the absence of active intervention malaria will return to an intrinsic equilibrium determined by factors related to ecology, efficiency of mosquito vectors, and socioeconomic characteristics. Understanding where and why resurgence has occurred historically can help current and future malaria control programmes avoid the mistakes of the past.

Methods: A systematic review of the literature was conducted to identify historical malaria resurgence events. All suggested causes of these events were categorized according to whether they were related to weakened malaria control programmes, increased potential for malaria transmission, or technical obstacles like resistance.

Results: The review identified 75 resurgence events in 61 countries, occurring from the 1930s through the 2000s. Almost all resurgence events (68/75 = 91%) were attributed at least in part to the weakening of malaria control programmes for a variety of reasons, of which resource constraints were the most common (39/68 = 57%). Over half of the events (44/75 = 59%) were attributed in part to increases in the intrinsic potential for malaria transmission, while only 24/75 (32%) were attributed to vector or drug resistance.

Conclusions: Given that most malaria resurgences have been linked to weakening of control programmes, there is an urgent need to develop practical solutions to the financial and operational threats to effectively sustaining today's successful malaria control programmes.

- 208 reports
- 75 resurgence events
- 61 countries
- 1930s through the 2000s

Cohen et al. *Malaria Journal* 2012, **11**:122
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Malaria resurgence

- The potential **fragility** of such gains in malaria elimination.
- **Resurgence:** “*the **reappearance** of new infections in **significant numbers** after malaria has **subsided** owing to **the measures applied** to reduce or interrupt its transmission*”.
- “A **malaria resurgence** is actually the return to **a state of equilibrium** which has been **disturbed**” by malaria control efforts.

Malaria resurgence

- Although malaria can be reduced from **that baseline** (**intrinsic potential**) by implementation of effective control measures, in the absence of active suppression malaria will return to a prevalence level determined by R_0 .
- This **intrinsic potential** for malaria transmission may evolve slowly as a function of **socioeconomic** development or **environmental change**.

Causes of Malaria Resurgence

- Three overarching categories were used to classify causes (not mutually exclusive)
 1. Weakening of the malaria programme (68/75 = 91%)
 2. Increasing intrinsic potential for malaria transmission (44/75 = 59%)
 3. Technical problems such as insecticide or drug resistance

WEAKENING OF THE MALARIA PROGRAMME

Weakening of the malaria control programme

- Programmatic weakening was attributed to a variety of causes (not mutually exclusive), including:
 - Funding shortages as the single most commonly cited reason (54%)
 - Complacency and other issues with poor execution (47%)
 - War or disaster (25%)
 - Purposeful cessation of control activities (25%)
 - Community non-cooperation (10%)

Weakening of the malaria control programme

- Reasons for funding reductions or cessation were not clear for all events
- In several, donors appear to have **reallocated funding** specifically **because successful reductions in malaria burden** had occurred.

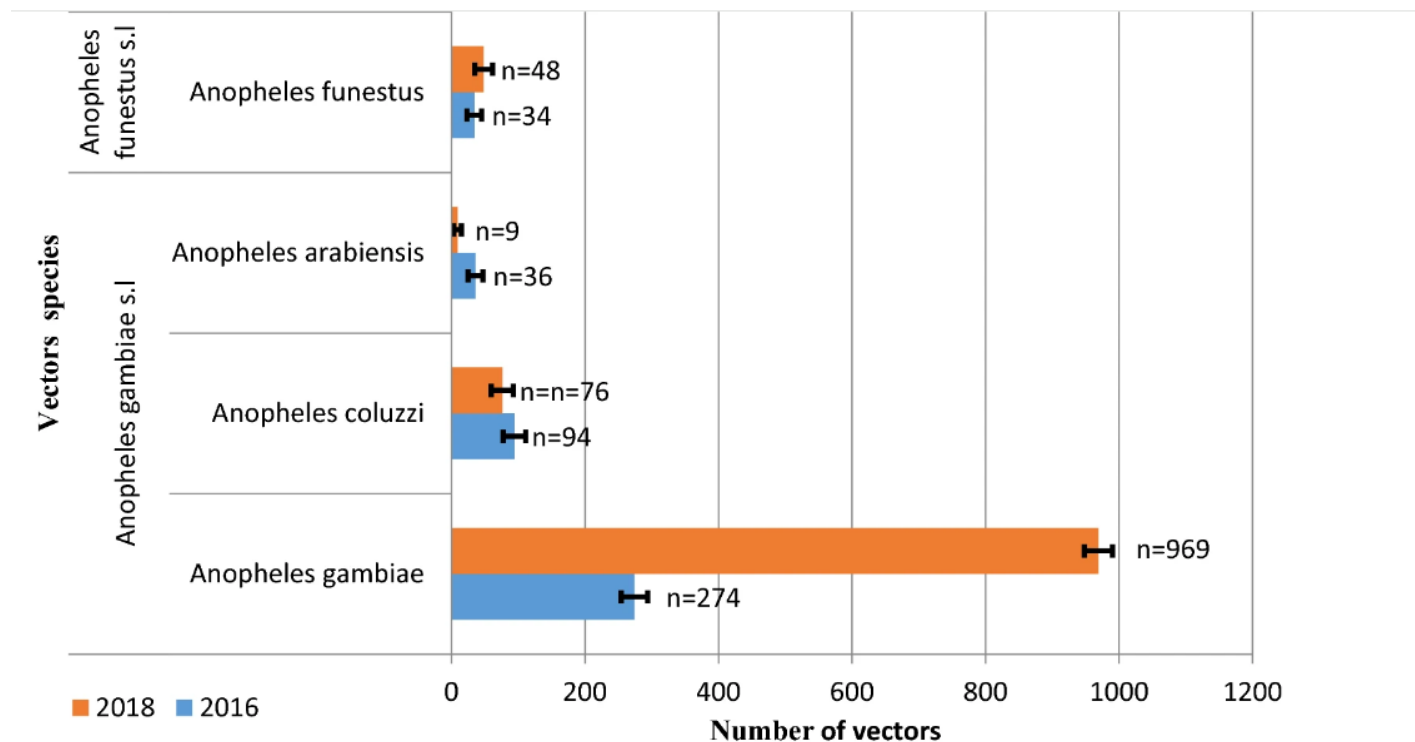


Weakening of the malaria control programme

- A sense of **complacency** within the programme or government resulting from **the perception that malaria was no longer a threat**.
- In **Mauritius**, for example, **successful certification of elimination** was said to have led to a laxness in control: regular testing for malaria was halted and vector control was scaled back, providing an ideal environment for malaria to return following the trigger of a natural disaster.

Upsurge of malaria transmission after indoor residual spraying withdrawal in Atacora region in Benin, West Africa

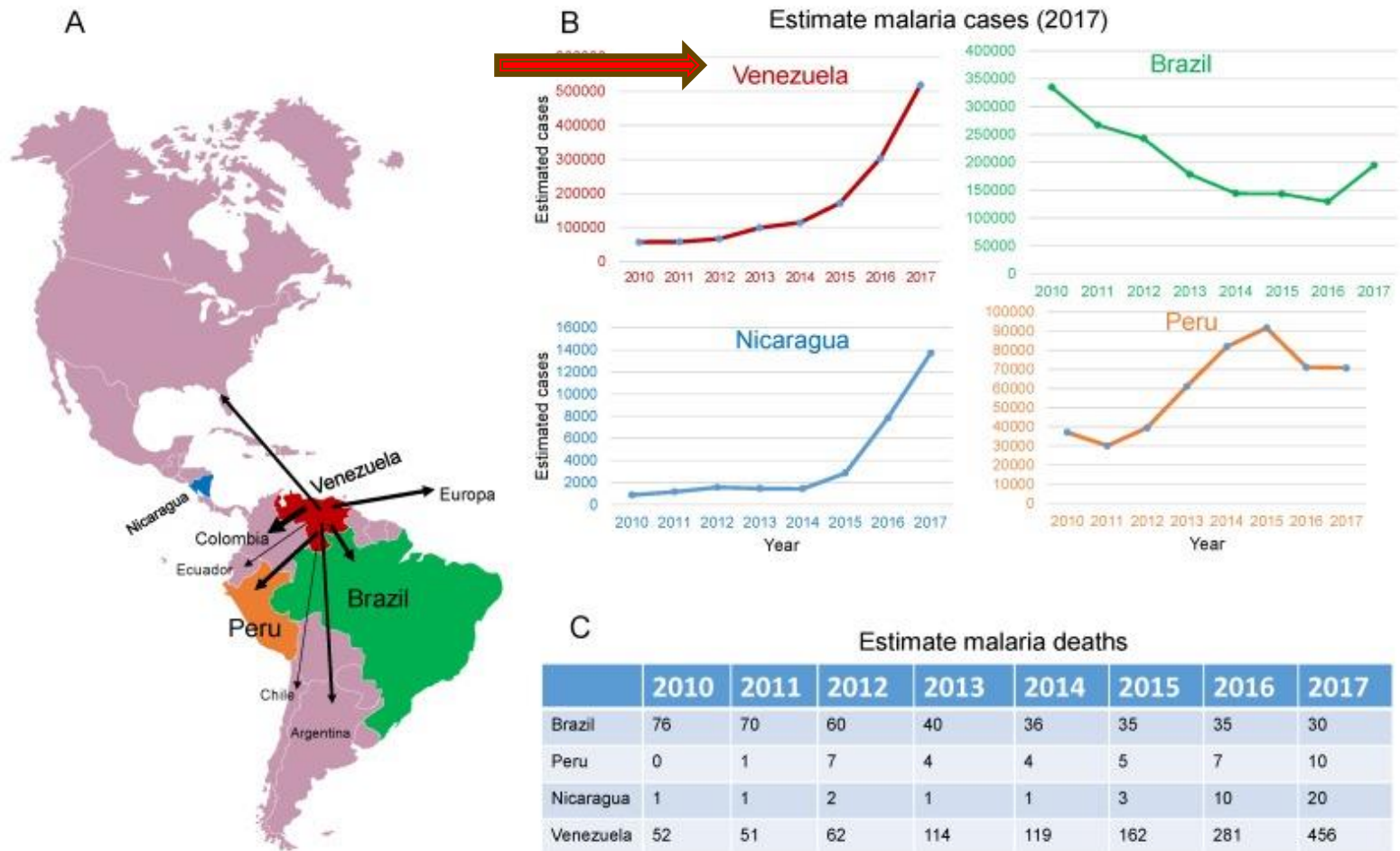
- In 2017 the programme was **withdrawn** from two regions in the northern part of the country, with hopes that gains would be relatively sustained because of **the seasonality of malaria transmission**.



Resurgence of malaria in Uganda despite sustained indoor residual spraying and repeated long lasting insecticidal net distributions

- Five years of sustained indoor residual spraying (IRS) of insecticide from 2014 to 2019,
- Following the implementation of IRS cases were:
 - 84% lower in years 4–5
 - 43% lower in year 6
 - 39% higher in the first 9 months of year 7
 - A resurgence in malaria to pre-IRS levels despite sustained IRS.
 - The timing of this resurgence corresponded to a change of active ingredient.

Malaria Resurgence in the Americas: An Underestimated Threat



Malaria Resurgence in the Americas: An Underestimated Threat

- Intensive malaria control efforts allowed **Venezuela** to be recognized in **1961** by the WHO as **the first country in the world to eliminate malaria** in its most populated area.
- Between **2000** and **2015**, cases increased by **365%**
- In **2017** alone, Venezuela accounted for **53%** of **all confirmed and presumed cases** of malaria in the Americas

The major determinants of the malaria resurgence in Venezuela

- A severe shortage of first-line antimalarial drugs
 - scarce investment in vector control measures
 - loss of equipment and infrastructure
 - a collapsed health system as a result of the ongoing political and economic crisis
 - illegal mining activities in areas with high malaria transmission
- ❖ malaria cases in Venezuela have spilled over to other neighboring countries in the region.

INCREASES IN MALARIA POTENTIAL

Increases in malaria potential

- Increases in **intrinsic malaria potential** were attributed to a variety of causes (not mutually exclusive), including:
 - **Movement of humans or mosquitoes** ($32/44 = 73\%$)
 - Development and **land-use changes** ($19/44 = 43\%$)
 - **Climate or weather** ($11/44 = 25\%$)
 - **War and civil strife** ($8/44 = 18\%$)
 - **Worsening of socioeconomic conditions** ($5/44 = 11\%$).

CLIMATE CHANGE & MALARIA UPSURGE



Climate change & malaria

- WHO has declared **climate change** the **single biggest health threat** facing humanity.
- Climate change and its interaction with **malaria transmission** is **complex**, and empirical **evidence** to support reliable predictions is **sparse**.
- **Temperature**, **rainfall** and **humidity** influence larval development, mosquito survival, parasite development within the mosquito and vector competence.
- Changes in these aspects will affect **vectorial capacity**.

Vectorial Capacity

- **Vectorial capacity** is defined as the number of new infections that the population of a given vector would induce per case per day at a given place and time.
- **Vectorial capacity** is **the potential number of secondary cases** originating from one primary case in **one day**, assuming that the human population is, and remains, fully susceptible.

Vectorial Capacity

- **Vectorial capacity** measures the potential of the mosquito population to transmit malaria in a region.
- Vectorial capacity **does not measure** the amount of malaria in a population, nor the intensity of transmission.
- It measures **the capacity of a local vector system to transmit**, determining the potential transmission intensity.
- It is possible to have **a high vectorial capacity** in the **absence of malaria**.

Summary of vectorial capacity

- The primary, infective, **case** is bitten by a certain number of female **anophelines** of a certain species **per day** (**ma**).
- A proportion of these **mosquitoes** **get infected** (c).
- A proportion of **these mosquitoes** **survive** the extrinsic incubation period, so they are alive and infectious (e^{-ng}).
- They **bite a certain number of humans** before they die (a/g).
- Some of **these humans** **get infected** (b).

$$C = \frac{ma^2bce^{-ng}}{g}$$

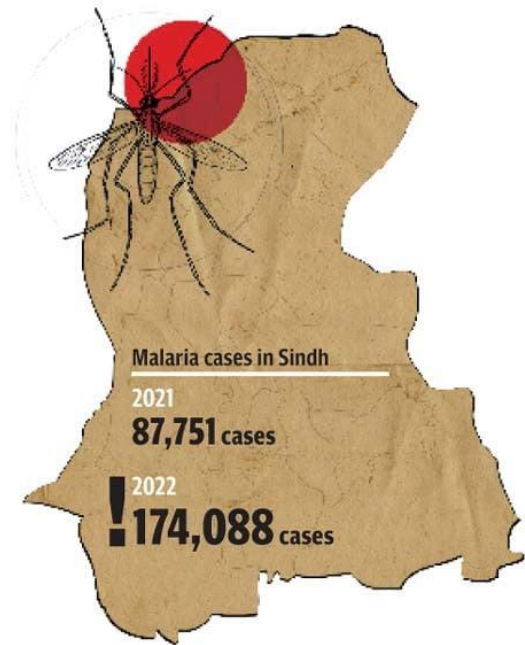
Note that **a** and **g** are the really important determinants. They depend on **vector species**, availability of **alternative blood sources** and very much on **anti-adult vector control**. Finally, **n** depends on **parasite species** and **temperature**.

Anopheles stephensi invasion and spread

- **An. stephensi** poses a threat to malaria control and elimination in Africa, the Arabian Peninsula and southern Asia.
- The characteristics of this vector make its control challenging; for example, **An. stephensi** quickly adapts to the local environment, surviving extremely high temperatures during the dry season, when malaria transmission usually reaches a seasonal low.
- An. stephensi has exhibited **insecticide resistance**

Climate change & malaria

- In **2022** and **2023**, extreme monsoon rainfall and flooding affected many parts of **Pakistan**.
- A **fivefold** increases in malaria cases compared with the year before.
- The malaria cases substantially increased in provinces of **Balochistan** and **Sindh**.



Climate change & malaria

- A changing climate has indirect effects on malaria, too.
- As an example, **population displacement** may lead to more malaria as people without immunity migrate to endemic areas.
- Climate variability has also led to **malnutrition** in many places, a risk factor for **severe malaria** among **young children** and **pregnant women**.



TECHNICAL PROBLEMS

Technical problems

- Malaria resurgence was attributed primarily to two types of technical problems:
 - Vector resistance
 - Parasite resistance to antimalarial drugs
 - Parasite deletions of genes

Parasite resistance to antimalarial drugs (2015–2022)

- Efficacy of antimalarial drugs is monitored through **therapeutic efficacy studies (TES)**
- **WHO Eastern Mediterranean Region:** data on the efficacy of artemether-lumefantrine (AL), for the treatment of *P. falciparum* are available from Afghanistan, Pakistan, Somalia, Sudan and Yemen (2015–2020). **All demonstrated high treatment efficacy.** Data on the efficacy of the first-line treatments for *P. vivax* are available from one study of AL from Somalia (2018) and two studies of CQ in Afghanistan (2016 and 2022); **no treatment failures were observed.**

Vector resistance to insecticides

- Of the 88 malaria endemic countries that provided data for 2010–2020
 - 78 have detected resistance to at least one insecticide class in at least one malaria vector and one collection site
 - 29 have already detected resistance to pyrethroids, organochlorines, carbamates and organophosphates across different sites
 - 19 have confirmed resistance to all four classes of insecticide in at least one site and at least one local vector.

Parasite deletions of genes

- **Parasite deletions of genes** (*P. falciparum* parasites that do not express histidine-rich protein 2 (**HRP₂**) may escape detection by RDTs based on detection of HRP₂).
- Further, the histidine-rich protein 3 (**HRP₃**) protein, a homologue protein of HRP₂, can **cross-react** with the monoclonal antibodies used for HRP₂ detection at high parasite densities.
- Studies of Pfhrp2 deletions were published for the first time in 2022 in six countries (Burundi, Cambodia, Cameroon, Sierra Leone, South Sudan and Viet Nam), of which only **Burundi** and **Viet Nam** did not detect Pfhrp2 deletions.

FRAME HEALTH DIPLOMACY EFFORTS FOR CROSS-BORDER COLLABORATION

Solutions and policy recommendations for improving cross-border cooperation in healthcare

Capacity-Building

- Ministries of foreign affairs need to ensure that global health diplomacy is included in the training and education of diplomats. Joint education and training between health experts and diplomats should also be encouraged.
- Health diplomacy training imparted to mid-level and senior officials in the public as well as private sector. Training to inculcate an understanding of global health diplomacy and governance
- Investments in healthcare infrastructure projects take several forms, including the construction of new facilities, the upgrading and modernization of existing infrastructure, and the provision of medical equipment and resources.

Solutions and policy recommendations for improving cross-border cooperation in healthcare

Legislation, Coordination, and collaboration

- Coordination with **other agencies and organizations** which can support a common health agenda, such as the Organization of Islamic Cooperation (OIC), must be made use of and close collaboration sought.
- More **contact** should be established between **parliamentarians** and **other decision-makers** with regard to **health issues** in national security and **national legislation**, and to get them interested and involved in committees where health is impacted.

Solutions and policy recommendations for improving cross-border cooperation in healthcare

Enhancing Global Health Cooperation

- With the aim of enhancing regional health cooperation, G5 seeks to foster collaboration between participating countries across various health-related domains, including **disease prevention and control, public health policy, medical research, and the development of healthcare technologies.**
- By facilitating knowledge exchange, capacity building, and **joint initiatives**, the G5 has the potential to contribute to improved global health outcomes and address shared health challenges more effectively.

Solutions and policy recommendations for improving cross-border cooperation in healthcare

Information sharing

- The collection of cross-border **qualitative and quantitative data** and the production of original cross-border healthcare-related information need to be promoted.
- This includes **mapping cross-border and border health operators and partners** to emphasize the importance of cross-border flows and to help **cross-border initiatives**.
- The **Region's experiences, best practices and achievements** in global health diplomacy should be analyzed and **shared widely** also with other countries. The **G5 secretariat** could be designated for this purpose.



جنگل گلستان