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REVIEW

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Imported malaria: a silent and forgotten threat in malaria free zones?

Novyan Lusiyana[1,2], Riris Andono Ahmad[3,4], Iqbal Elyazar[5,6] and E. Elsa Herdiana Murhandarwati[7*]

Abstract

Background Countries that declared free of malaria remain vulnerable to the reintroduction and re-establishment of malaria transmission, primarily triggered by the influx of imported malaria. This risk is particularly acute in regions with population movement from endemic zones, limited tracking capacity, or continued presence of competent vectors. Experiences from countries navigating these vulnerabilities can provide valuable lessons for regions currently progressing or sustaining malaria elimination.

This study aims to present various strategies and lessons learned in controlling imported malaria and preventing its reintroduction in regions that have reached malaria elimination and maintenance.

Methods A systematic literature search was conducted using the PRISMA ScR framework. Articles were retrieved from three databases (PubMed, Scopus, and ProQuest) and screened based on inclusion and exclusion criteria. The review focused on imported case surveillance, vector surveillance, vector controls, and other measures. Imported case surveillance comprised case detection, as well as case management, and preventive measures.

Results Among the 149 articles reviewed, 24 were selected for in-depth analysis. Reintroduction events were primarily driven by imported cases from endemic areas, with contributing factors including cross-border population movements, conflicts in countries of origin, and international travel. Additionally, the presence of competent mosquito vectors and the expansion of breeding habitats have facilitated local transmission following importation. All studies implemented imported case surveillance, with case detection activities reported (21 articles) and case management (4 articles) studies. Additionally, some studies included mass drug administration (3 articles) and chemoprophylaxis interventions (3 articles). Several countries incorporated vector surveillance (6 articles), vector control measures (7 articles), and other activities such as cross-border initiatives (3 articles), health promotion (3 articles), and modelling studies (1 article).

Conclusion The successful prevention of malaria reintroduction has been achieved in countries that implemented comprehensive imported malaria surveillance strategies. Lessons learned indicate that case-based surveillance alone is insufficient; it must be complemented with additional interventions and context-specific activities to ensure sustained elimination and prevent reintroduction.

Keywords Malaria, Elimination, Imported case, Reintroduction, Surveillance strategy

*Correspondence:
E. Elsa Herdiana Murhandarwati
elsa.herdiana@ugm.ac.id
Full list of author information is available at the end of the article

Background

More countries have successfully eliminated local malaria transmission. Twenty-six countries that were malaria-endemic in 2000 had successfully maintained 3 consecutive years without local transmission. Since 2023, the World Health Organization has officially certified Azerbaijan, Belize, Cabo Verde, Tajikistan, and Egypt as malaria free countries [1, 2]. In 2025, Suriname, Timor-Leste, and Georgia were officially certified by the World Health Organization as malaria-free countries [3]. Following malaria elimination, it is crucial to shift their programmatic focus toward preventing reintroduction.

Malaria re-emergence is often linked to population movement from endemic regions, areas with competent vectors and favourable climate conditions [3]. A notable example is the Republic of Korea where malaria reappeared in 1993 after a decade of elimination [4]. Similarly, Iran reported a resurgence of almost 1439 indigenous malaria in 2022 after 4 years of malaria-free [1]. Multiple factors may contribute to reintroduction, including environmental and climatic conditions, competent vector presence, population mobility, the strength of control strategies, and institutional response capacity [5]. Many malaria-free regions share borders with areas where malaria remains endemic [6]. Increased human mobility, transportation, and interregional conflicts may lead to the migration of individuals from endemic to non-endemic regions [7].

To prevent the re-entry of malaria into malaria free regions, a range of strategies have been implemented, including case surveillance for imported cases, entomology surveillance, and vector control. Some of these strategies emerged in response to previous failures in controlling imported malaria [7]. Likewise, innovations in detection methods have been driven by earlier challenges in managing imported cases [8]. This review aims to provide an overview of key strategies used to control imported malaria and to highlight lessons learned from countries that have successfully eliminated indigenous malaria.

Methods

Information sources and search strategy

This scoping review was conducted following the PRISMA ScR framework. A systematic literature search was performed using three databases: ProQuest, Scopus, and PubMed. The search strategy utilized a combination of keywords such as "malaria," "Plasmodium infection," "imported malaria," "control strategy," "elimination," "post-elimination," and "reintroduction", which were structured using Boolean operators as outlined in Table 1. The review was guided by the PCC (Population, Contents, Concepts) framework to ensure relevancy and consistency in article selection.

Population (P)

This review encompasses articles that provide information on individuals or populations diagnosed with imported malaria, as defined by the World Health Organization (WHO), cases in which infection was acquired outside the area where the case was diagnosed [9].

Contents (C)

This review examines a range of malaria control interventions targeting imported cases, particularly those with the potential to trigger outbreaks or lead to reintroduction. These interventions include surveillance of imported malaria, surveillance of vector mosquitoes and environment, and outbreak management.

Table 1 Search terms for malaria imported case

Framework	Terms	Connector
Population	Malaria OR Plasmodium infection OR forest workers OR forest goers OR foreign visitors OR imported cases OR immigrants OR internal displaced OR malaria migration OR malaria import OR military OR miners OR mine workers OR migration OR migrant* worker OR mobile migrant OR overseas* workers OR refugees OR seasonal laborer OR students OR tourists OR traveller* OR visit friends and relatives	AND
Content	Control intervention OR control method* OR control program* OR elimination strategy OR innovation OR integrated malaria control OR malaria control OR malaria monitoring OR prevention of malaria OR preventive measure OR preventive of re-establishment OR strategy and intervention OR surveillance OR surveillance system OR mass drug OR malaria treatment OR mass screening and treatment OR management malaria OR drug resistance OR anti-malarial resistance OR human surveillance OR mobile approaches OR diagnostic testing OR molecular survey OR zero-prevalence OR mass screening OR community intervention OR community participation OR intersectoral OR public–private partnership OR multisectoral OR environmental vector OR environmental management OR vector control OR vector surveillance OR mosquito control OR anopheles control OR insecticide-treated nets OR integrated vector management OR indoor residual spraying OR vaccines	AND
Concept	Elimination OR introduced plasmodium OR malaria-free OR malaria elimination OR non-endemic OR outbreak OR post-elimination OR receptive OR reintroduction OR re-emergence OR remote area OR retransmission OR vulnerable OR Asia OR Europe OR Africa OR Sub-Saharan Africa OR America OR Asia–Pacific	AND

Concept (C)

This review focuses on regions that have achieved malaria elimination, where no indigenous human *Plasmodium* infections occur. It also includes countries in post-elimination settings, countries in the prevention of re-establishment (POR) phase, and receptive non-endemic countries that receive large inflows of migrants from malaria-endemic areas.

Eligibility criteria

The literature search was limited to English-language publications, with no restrictions on the year of publication or study location. This inclusive approach was intended to capture a comprehensive understanding of malaria importation control strategies from countries or regions that have eliminated indigenous transmission of human malaria, countries were in the elimination phase, countries were in the POR phase. Articles that did not address strategies for managing imported malaria were excluded. This scoping review included articles with both quantitative and qualitative study designs. Articles that focused solely on imported malaria case descriptions, risk factor analyses, laboratory or molecular investigations, genotyping, knowledge-attitude-practice (KAP) assessments, or study protocols were excluded.

Data extraction

Following article retrieval from the three databases, duplicates were removed and a screening process based on titles and abstracts was conducted. Two investigators independently performed the screening with articles relevant to the scoping review topic advanced to full-text review according to predefined inclusion and exclusion criteria. Reasons for article exclusion were recorded, and disagreements were resolved through discussion between the investigators. Articles that met the eligibility criteria were systematically characterized based on title, author(s), year of publication, study location, methodology, type of strategy, key findings, and recommendations, as presented in Table 2. In addition, malaria importation case surveillance was further characterized in Table 3, covering incidence or importation rates, surveillance methods, *Plasmodium* species, types of importation, and the origin or domicile of imported malaria.

Results

A total of 2026 articles were retrieved from PubMed, Scopus, and ProQuest. After removing 338 duplicates, 1688 articles remained for title and abstract screening. Of these, 149 articles met the criteria for full-text review, and ultimately, 24 articles were included in the final analysis, as illustrated in Fig. 1.

Study characteristics

A total of 24 articles on strategies for controlling malaria importation, published between 2004 and 2024, were included in the analysis. A marked increase in research output was observed over the last 9 years (2016–2024), with China and Sri Lanka contributing the highest number of studies (eight and seven articles each country). Other countries represented included Greece (two articles), as well as Singapore, France, Canada, Qatar, Spain, and Malaysia (one article each). Geographically, majority of studies were conducted in Asia (18 articles), followed by Europe (4 articles), Africa (1 article), and America (1 article). Most of the studies utilized observational study designs, with one using a modelling approach to inform malaria control strategies.

Characteristics of imported malaria

Imported malaria reported in malaria-free countries primarily originates from endemic regions across Africa and Asia [7, 10–14]. In Africa, the main source countries include Angola, Mali [15, 16], Equatorial Guinea [13, 15, 16], Nigeria [10, 15], the Democratic Republic of the Congo [10, 11, 15], Cameroon [15], Burundi [11], Togo [13], Benin [13], Sierra Leone [13], Ghana [10, 13, 15], Mauritania [13], Tanzania [10, 11, 15], Rwanda [11], Malawi [10, 11, 15], Sudan [10, 15], Ethiopia [15], and Madagascar [10]. From Asia, key imported source countries include Pakistan [6, 8, 10, 15], Afghanistan [6, 8], Bangladesh [6, 8], Indonesia [10, 15, 17], Malaysia [10], Myanmar [7, 15], Brunei [15], India [6, 10, 18–20], Iran [6], and Papua New Guinea [6, 16, 21, 22]. Patterns of malaria importation vary widely, with several cases associated with conflict-affected regions [11, 13], or military deployments in endemic conflict zones [4, 23]. Border area are particularly affected, such as the China–Myanmar where most cases are imported from Myanmar [24].

The destination countries of imported malaria cases often reflect the geographic origin of the infected individuals. In China and Sri Lanka, most imported cases stem from Southeast Asia and are commonly associated with field technicians and China–Myanmar cross-border residents [6, 25, 26, 29]. In Europe, imported malaria cases mainly originate from Africa and South Asia, with affected populations largely consisting of immigrants and refugees [7, 8, 11, 16]. A wide range of occupations have been identified among those affected by imported malaria. These include outdoor workers [6, 15, 21, 25, 26], individuals with a history of travel to endemic areas [10, 27], travellers [10, 14, 20, 21], seafarers [10], refugees [11], immigrants [7, 13], pilgrims [14], cross-border residents [6, 24] and victims of human trafficking or smuggling [13]. Several studies have also reported military

Table 2 Strategies for controlling and recommendation to control imported malaria cases

No	Study, years of publication	Study location	Control strategy	Results	Recommendation
1	Ndao et al., 2004 [11]	Quebec Canada	Malaria case surveillance among refugees primarily utilized standard microscopy, supplemented by ICT and PCR testing during large influxes of refugees from malaria-endemic areas	Malaria case surveillance was adequate to detect imported malaria among refugees and the prevalence was 18.8%, and all cases were asymptomatic	Identification of clinical manifestations and appropriate study design to determine whether treatment should be administered without prior screening among refugees
2	Lee et al., 2010 [25]	Tekong, Singapore	Prevention of importation through malaria screening of military personnel and workers using RT-PCR Malaria education (personal protection) for healthcare workers and military personnel Vector control through environmental improvements and insecticide use (*Bti*, fogging, larval insecticide, IRS) Cross-sectoral collaboration between laboratories, hospitals, the Ministry of Health, and Singapore's environmental agency	Screening effectively detected imported malaria cases (7 out of 8303 incoming workers) Combined vector control reduced *Anopheles* mosquito capture rates by 94% No malaria cases were found after control measures were implemented Multisectoral collaboration sustained elimination efforts	A broader strategy is required for malaria control over wider areas Reduction of chemoprophylaxis for military personnel after successful vector control should be considered Additional malaria case surveillance programmes are needed to detect imported malaria cases
3	Wickramage and Galappaththy, 2013 [13]	Sri Lanka	Malaria screening of international immigrants at airports	Malaria case surveillance detected four imported malaria cases among 287 immigrants, indicating an imported malaria risk of 14 per 1000 individuals	Malaria screening and information dissemination are needed for other at-risk populations, such as travellers, undocumented immigrants, and peacekeeping military personnel
4	Migliani et al., 2014 [30]	France	Vector control strategies to reduce contact with *Anopheles* Chemoprophylaxis Case management of malaria case Healthcare providers training Health promotion for soldiers Epidemiological surveillance	LLINs are the best protection tool against malaria if properly used and in a good condition The effectiveness of chemoprophylaxis among French soldiers limited by incomplete adherence, individual contraindication and operational challenges Case management of malaria in soldiers involves diagnosis, specific treatment regimens, management severe cause and radical cure based on patient condition Training on malaria control prevent outbreaks Health promotion involves structured education on malaria prevention Epidemiological strategies combining case notification, vector control and effective reduce malaria incidence	Malaria control in French armed forces requires maintaining expertise in tropical medicine and entomology, implementing a coordinate multidisciplinary approach
5	Tseroni et al., 2015 [7]	Greece	Mass drug administration (MDA) program Malaria surveillance as an evaluation of MDA effectiveness	No malaria cases were detected within 22 months post-MDA Malaria surveillance using the active case detection (ACD) method was effective in evaluating MDA success	Parallel studies should compare the effectiveness of MDA with previously applied conventional malaria control methods

Table 2 (continued)

No	Study, years of publication	Study location	Control strategy	Results	Recommendation
6	Zeng et al., 2016 [6]	Yunan, China	Malaria case surveillance among residents and mobile populations along the China-Myanmar border	Malaria testing rates were high among local Chinese residents at the Yunnan-Myanmar border, but declined among mobile populations. Not all border surveillance officers possessed adequate microscopic diagnostic skills	Malaria diagnostic efficiency should be improved through the development of rapid diagnostic tests (RDTs) Malaria screening should be optimized, particularly for mobile populations in border areas
7	Chehab et al., 2018 [12]	Qatar	Malaria case surveillance using passive case detection (PCD) Reporting of imported malaria cases to the Ministry of Health	Migration case surveillance successfully detected imported cases of malaria in Qatar The average time from symptom onset to notification to the Ministry of Health was 6 days. The average time from symptom onset to diagnosis was 4 days, and the average time from diagnosis to notification was 2 days	Public education on malaria and diagnostic guidelines for physicians is needed to expedite diagnosis and reporting of import cases
8	Dharmawardena et al., 2017 [10]	Sri Lanka	Malaria case surveillance using microscopic methods Anti-malarial treatment and parasitaemia evaluation up to 28 days post-therapy	Imported malaria cases ranged from uncomplicated to complicated, with significant diagnostic delays from symptom onset Treatment followed by evaluation improved program effectiveness	Strategies are needed for the early diagnosis of imported malaria Further studies should assess the resistance to anti-malarial drugs
19	Fernando et al., 2017 [29]	Sri Lanka	Malaria screening among military personnel at the airport using RDT Evaluation of malaria testing 4 months post-arrival	Two soldiers tested positive for malaria One *Plasmodium ovale* infection was undetected in the initial screening	Adequate diagnostic and treatment logistics should be available for military personnel deployed to malaria-endemic regions Malaria prophylaxis and rapid diagnosis should be strictly monitored
10	Wickremasinghe et al., 2017 [14]	Sri Lanka	Free chloroquine chemoprophylaxis was provided to Sri Lankan residents traveling to malaria-endemic countries such as India	Chemoprophylaxis accounted for 0.65% of Sri Lanka's total budget over 1 year	Chemoprophylaxis alone is not sufficient for preventing the reintroduction of imported malaria; it should be combined with repellents, long-sleeved clothing, and bed nets
11	Dharmawardena et al., 2019 [20]	Sri Lanka	Migration surveillance was conducted among patients in the hospital ward who presented with fever symptoms	Four cases of imported malaria were identified among inpatients	Administrative simplification of malaria migration surveillance in hospitals is necessary
12	Karunasena et al., 2019 [18]	Sri Lanka	Migration surveillance of immigrant construction workers from India, followed by contact surveys with residents Vector surveillance and control using bed nets and indoor residual spraying (IRS)	One case of imported malaria from India and one introduced case in a Sri Lankan resident were identified High vector density was observed in areas where imported cases of malaria were detected	Supervision and screening of incoming migrants, particularly from endemic areas, are required Routine entomological surveillance is necessary in Sri Lanka
13	Fradejas et al., 2019 [16]	Madrid Spanyol	Case surveillance of immigrants from endemic countries using screening criteria Detection of asymptomatic microscopic and sub-microscopic malaria in immigrants	Malaria prevalence among immigrants from endemic areas was 29.7% The prevalence of asymptomatic microscopic, and sub-microscopic malaria was 22 and 5.7%, respectively	Intensification of malaria screening protocols for immigrants in non-endemic areas is needed Screening of afebrile immigrants should use molecular techniques

Table 2 (continued)

No	Study, years of publication	Study location	Control strategy	Results	Recommendation
14	Wang et al., 2019 [15]	Shanxi, Cina	Case surveillance of immigrants from malaria-endemic areas using the 1–3-7 method	The prevalence of imported malaria was very low, despite the average time from symptom onset to diagnosis not meeting standards	The development of malaria control strategies is necessary
15	Marasinghe et al., 2020 [19]	Sri Lanka	Mass drug administration (MDA) uses chloroquine and primaquine for immigrant workers from India	MDA among high-risk populations successfully prevented reintroduction	G6PD deficiency screening is necessary before MDA
16	Tseroni et al., 2020 [8]	Greece	Mass drug administration for malaria Imported malaria case surveillance using the passive case detection (PACD) method	MDA coverage reached 87.3% PACD sensitivity was very high, indicated by improved diagnostic timeliness (83%) and reduced malaria transmission	More effective diagnostic methods for sub-clinical malaria are needed
17	Dai et al., 2021 [21]	Shanghai China	Malaria management using the 1–2-3 + 1 method Identification of malaria transmission foci across Shanghai to determine targeted management Vector surveillance using light traps	Malaria transmission risk in Shanghai was very low The number of potential malaria transmission foci declined in the post-elimination phase, mostly in rural areas Vector density in Shanghai was very low	Risk assessment and vulnerability evaluation in elimination-receptive areas, along with monitoring of the surveillance system are necessary Health worker training and multisectoral collaboration are essential to maintaining elimination and preventing reintroduction Case investigation and targeted responses are required during peak vector population periods
18	Lin et al., 2021 [24]	Yingjiang China	Cross-border cooperation between China and Myanmar for malaria prevention and control using the 3 + 1 method Vector surveillance and control (LLINs, IRS)	Malaria control in Myanmar and China using the 3 + 1 method was effective The annual parasite index (API) in Myanmar decreased by 89% during the program implementation	Program evaluation in the China-Myanmar border area is needed to assess overall effectiveness
19	Naserrudin et al., 2021 [17]	Sabah Malaysia	Malaria surveillance using mass blood surveys during outbreaks and the identification of sub-microscopic malaria Vector surveillance and control using IRS, LLINs, and larviciding	Fourteen symptomatic malaria cases and > 60% asymptomatic Plasmodium malaria cases were identified Many Anopheles nulliparous mosquitoes were found to be sporozoite-free, with the nearest breeding habitat located 50 m from the index case	Collaboration between authorities and companies is necessary for effective malaria treatment and prevention of vector exposure among workers
20	Cao et al., 2022 [26]	Jiangsu China	Malaria surveillance using the 1–3-7 method A dedicated national malaria control institution Community malaria education	The 1–3-7 method was well-implemented, with a median diagnosis time of 2.13 days from symptom onset Case detection efficiency improved, with increased malaria testing and a reduction diagnosed cases Leaflets and social media were effective for malaria education	Sustained malaria promotion (knowledge, treatment behaviour), diagnostic competency, and malaria reporting efforts are needed to maintain elimination

Table 2 (continued)

No	Study, years of publication	Study location	Control strategy	Results	Recommendation
21	Li et al., 2022 [31]	Hainan China	Outbreak control using the three-layer survey (TLS) method Malaria surveillance using active and passive case detection (ACD and PCD) Vector surveillance and control using IRS and LLINs Health worker training (including doctors and laboratory staff) Mass chemoprophylaxis for forest goers in three-tiered areas	The TLS strategy effectively controlled malaria outbreaks in Hainan, China ACD was more effective than PCD in detecting malaria Three *Anopheles* species with varying distribution patterns were identified All healthcare workers from 13 study districts participated in the training Chemoprophylaxis coverage was 89.4%	The TLS method should be adjusted for each region to control the outbreak
22	Zhang et al., 2024 [22]	Anhui, China	The adaptive malaria importation control method is based on four key aspects: government leadership, surveillance, and response, intersectoral collaboration, and capacity building of resources	The implementation of the adaptive surveillance method increased the number of visits and diagnoses of individuals with malaria from endemic areas. Additionally, it improved the timeliness of identifying *Plasmodium* species	A long-term evaluation is needed to measure the impact of the adaptive surveillance method
23	Mendis et al., 2024 [33]	Sri Lanka	Case detection Entomological surveillance Case management of malaria	During pandemic PACD method detected a higher proportion of imported cased, while PCD remain the main contributor Entomological surveillance was reduced, targeting locations most likely to harbour malaria-infected case and receptive area All confirmed malaria case maintaining routine follow-up and ensuring adherence to malaria treatment	Continued for malaria screening with monitoring system were recommended, with emphasis on PACD to enhance early detection of imported case
24	Makinde & Okosun, 2011* [32]	South Africa	Developed a malaria transmission dynamics model incorporating variables such as immigrant presence, treatment, and insecticide spraying	Malaria control is most effective when combining three variables: treatment, insecticide spraying, and immigrant control Achieving a malaria-free condition is difficult if there are individuals infected with malaria in the community The most sensitive parameters for malaria transmission are contact with mosquitoes and biting rates of mosquitoes The presence of infected immigrants does not contribute to malaria transmission if proper treatment and mosquito control measures are in place	–

*Mathematical modelling study

Table 3 Characteristic of case finding, diagnostic methods and type of imported case

Author	Location	Incidence / importation rate	PCD	ACD	RCD/ RACD	Microscopic	RDT/ICT	PCR	Type of plasmodium	Case type	Continent of origin
Ndao et al., 2004 [11]	Canada	6.7%	–	v	–	v	v	v	Pf*, Pv, Po, Pm, Pmix	Refugees	Import (Africa)
Lee et al., 2010 [25]	Singapore	0.08%	–	v	–	–	–	v	–	Outdoor workers	Domestic travellers
Wickramage and Galappaththy, 2013 [13]	Sri Lanka	14 cases per 1000	–	v	–	v	v		Pf*, Pv	Immigrant	Import (Africa)
Migliani et al., 2014 [30]	France	71%	–	v	–	–	–	–	Pf*, Pv	Military personnel	Military travellers Import (Africa)
Tseroni et al., 2015 [7]	Greece	91 cases	–	v	–	v	v	v	–	Immigrant	Import (Asia)
Zeng et al., 2016 [6]	China	85%	v	–	–	v	–	–	Pf, Pv*	Workers, mobile migrant population	Import (Asia)
Chehab et al., 2018 [12]	Qatar	493 cases	v	–	–	v	–	–	–	–	Import
Dharmawardena et al., 2017 [10]	Sri Lanka	74 cases	v	–	–	v	–	–	Pf, Pv*, Pm, Po, Pk	Tourist, seaman	Domestic and import (Africa, Asia)
Fernando et al., 2017 [29]	Sri Lanka	30.8%	v	v	–	v	v	–	Pf, Pv	Military personnel	Domestic travellers
Wickremasinghe et al., 2017 [14]	Sri Lanka	5.25–13.45 cases per 1000	v	–	–	v	–	–	Pf, Pv*, Pmix	Travelers, pilgrims	Domestic travellers and import (Asia)
Dharmawardena et al., 2019 [20]	Sri Lanka	51 cases	v	–	–	v	–	–	Pf, Pv	Travellers	Import (Asia)
Karunasena et al., 2019 [18]	Sri Lanka	2 cases	v	v	v	v	v	v	Pv	Foreign labourer, salesman	Import (Asia)
Fradejas et al., 2019 [16]	Spain	5.7–29.7%	v	–	–	v	–	v	Pf*, Pmix	Immigrant	Import (Sub-Saharan Africa)
Wang et al., 2019 [15]	China	90 cases	v	–	–	v	–	v	Pf*, Po, Pm, Pv, Pmix	Outdoor and indoor workers	Import (Africa*, Southeast Asia)
Marasinghe et al., 2020 [19]	Sri Lanka	3.1%	–	v	–	v	v	–	Pv	Foreign workers	Import (Asia)
Tseroni et al., 2020 [8]	Greece	3.6%	–	v	–	v	v	–	Pv	Migrant farm workers	Import (Asia)
Dai et al., 2021 [21]	China	436 cases	v	–	–	v	v	v	Pf*, Po, Pm, Pv	Outdoor workers and travelers	Domestic travellers and import (Africa*, Asia)
Lin et al., 2021 [29]	China	12.18–104.77 (API)	v	v	–	v	v	v	Pf, Pv*	Cross-border population	Abroad (Asia)
Naserrudin et al., 2021 [17]	Malaysia	60%	–	v	–	v	–	v	Pm	Logging workers, fishing, farming, hunting	Import (Southeast Asia)
Cao et al., 2022 [26]	China	8.1–22.9%	v	–	–	v	v	v	–	Laborers (lumberjack, infrastructure construction, driver)	Domestic travellers and import
Li et al., 2022 [31]	China	5 cases	v	v	–	v	–	v	Pm	Forest goer, farmer	Import (Southeast Asia)
Zhang et al., 2024 [22]	China	6.05–73.33%	v	v	–	v		v	Pf*, Po, Pm, Pv, Pmix	Overseas laborers	Import (Africa, Asia)
Mendis et al., 2024 [33]	Sri Lanka	30–57 cases	v	–	v	v	–	–	Pv	Military personnel	Military travellers

Pf (*Plasmodium falciparum*), Pv (*Plasmodium vivax*), Po (*Plasmodium ovale*). Pm (*Plasmodium malariae*), Pk (*Plasmodium knowlesi*), Pmix (*Plasmodium* mixed infection); *Dominant

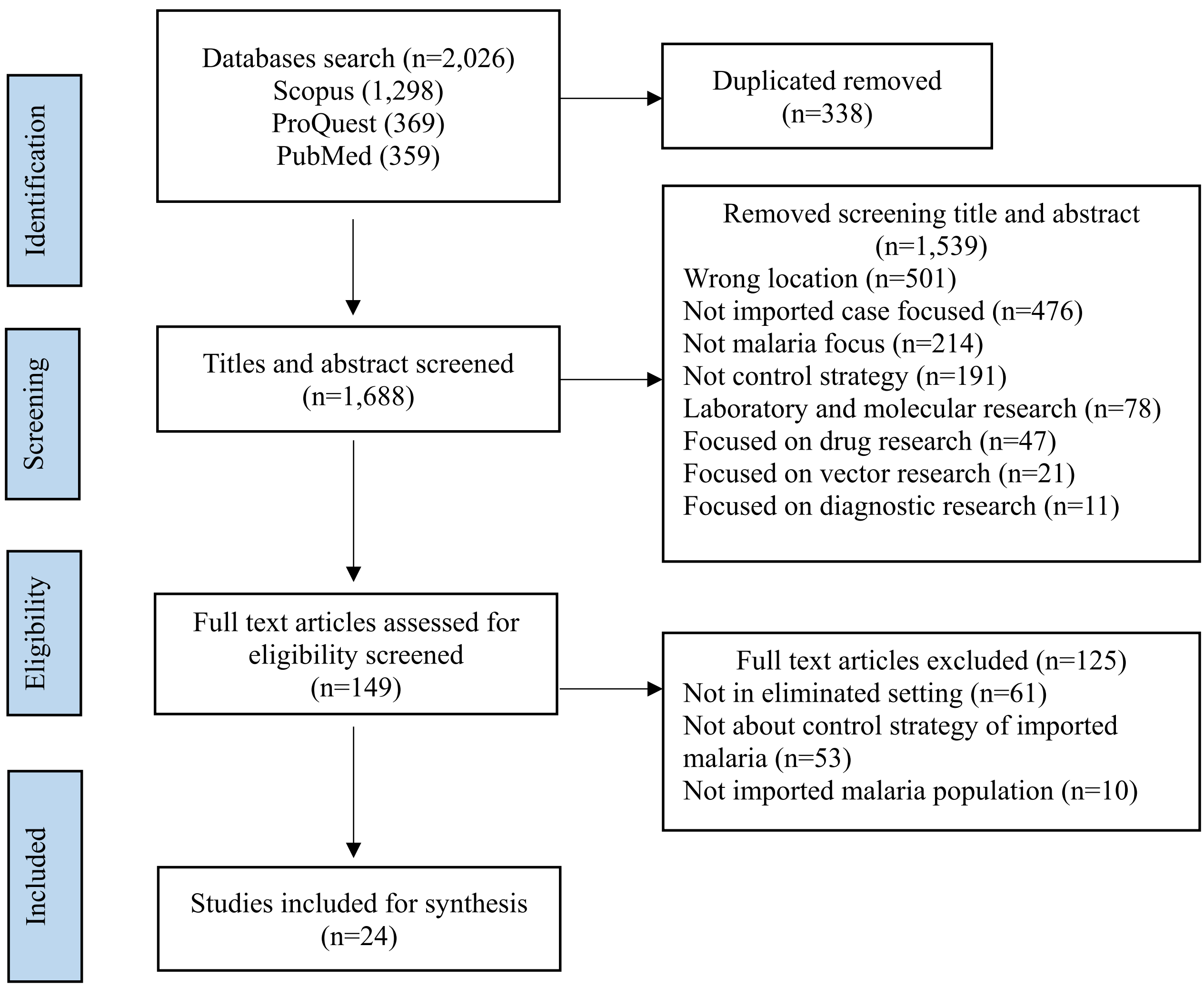

Fig. 1 Flow chart of SCR PRISMA

personnel as a recurring group affected by imported malaria [4, 10, 18, 23, 28, 29].

Thematic analysis

Table 2 outlines the strategies for controlling imported malaria, detailing both effective or ineffective outcomes along with key lessons learned from various countries. The analysis is organized into three thematic areas: Imported malaria surveillance, vector surveillance, and vector control. In addition, imported malaria surveillance consists of case detection, case management (treatment) and preventive measures, including mass drug administration (MDA) and chemoprophylaxis, that target populations at risk of malaria importation. Outbreaks resulting from the reintroduction of malaria cases, and the potential re-establishment of local transmission in malaria-free and receptive areas, can generally be prevented through a coordinated combination of case surveillance with vector surveillance, and vector control, as implemented in Singapore, France, Sri Lanka, Malaysia, and China [17, 18, 21, 25, 30]. Case surveillance encompasses case detection, case management, chemoprophylaxis, and mass drug administration, as implemented in China, Sri Lanka, France, and Greece [7, 10, 30, 31]. Vector surveillance includes investigation of breeding habitats, while vector control measures encompass IRS (indoor residual spraying), LLINs, and larviciding, as reported in China, France, Sri Lanka, and Malaysia [17, 18, 30]. Strengthened control efforts have included intersectoral collaboration, cross-border cooperation, and the application of mathematical modelling to guide policy [6, 17, 24]. In the health sector, capacity-building efforts—such as training healthcare workers in malaria diagnosis—have been critical in improving readiness and sustaining elimination.

Imported malaria surveillance

All studies reported the imported malaria. In China, the "1–3-7" strategy is implemented, which mandates malaria case reporting within one day, an epidemiological investigation within three days, and response measures within seven days [15, 21, 22, 26]. Sri Lanka follows a slightly accelerated "1–2-3" strategy: diagnosis within one day, parasitological and vector surveillance within 2 days, and case response within 3 days [18].

Common case surveillance methods for imported malaria include active case detection (ACD) and passive case detection (PCD). These methods can be further refined into proactive case detection (PACD) and reactive case detection (RACD/RCD), as seen in Greece [8]. The choice of case surveillance method depends on the context and characteristics of imported cases. For example, Greece, which faced a high influx of African immigrants in refugee camps, found PACD effective for detecting imported malaria [8]. In outbreak settings, ACD combined with mass blood surveys (MBS) has demonstrated better case detection, as observed in Malaysia [17]. However, MBS is not universally applied during outbreaks, such as in China [31].

The success of the imported malaria surveillance systems is assessed using several metrics. In China, the average time for imported malaria patients to seek medical care was 1.29 days in Jiangsu, China [26], and 1 day in Anhui, China [22]. China achieved a 100% reporting rate of imported malaria cases within 1 day, 99.4% of epidemiological investigations completed within 3 days, and 98.3% of response actions implemented within 7 days [26]. These results underscore the robustness of China's surveillance system. Epidemiological investigation timelines vary by country. Sri Lanka mandates completion within 2 days [18], which is shorter than China's 3-day requirement [15, 21, 22, 26]. The distance coverage for epidemiological investigations ranges from 100 to 1000 m around the case location [7]. The interval between symptom onset and treatment-seeking ranges from 1 to 2 days, as observed in Greece and China [8, 15, 22], while the time from treatment-seeking to diagnosis is typically under 1 day. Overall, the duration from symptom onset to diagnosis spans from 1.7 to 5.1 days [10, 21, 22, 26].

Case detection

The most common employed strategy for controlling imported malaria is case detection. As shown in Table 3, microscopic examination remained the primary diagnostic method in countries such as China, Canada, Sri Lanka, Greece, and Qatar [6, 8, 11–13]. However, rapid diagnostic tests (RDTs) are also used in China, Greece, and Spain [8, 16, 26], particularly for screening at military personnel [29], as well as immigrants or travellers at entry points [13]. Certain *Plasmodium* species and sub-microscopic infections are more sensitively detected using molecular techniques, such as the identification of simian malaria (*Plasmodium knowlesi*) in Malaysia and the China–Myanmar border [17, 24]. A combination of microscopy and polymerase chain reaction (PCR) has proven effective in preventing local transmission during outbreaks, as demonstrated in Malaysia [17]. The diagnosis of imported malaria is often centralized in healthcare facilities, as seen in Spain using PCR, Sri Lanka, and China with the microscopic examination [16, 20]. Moreover, collaboration with international health organizations, such as USCDC and WHO has supported diagnostic efforts using both microscopic and molecular approaches, notably in China and Sri Lanka [6, 18, 22, 26].

Case management

Out of the 24 studies reviewed, seven studies discussed strategies for managing imported malaria cases. The seven studies originated from Greece, Sri Lanka, and China. Most imported malaria cases were uncomplicated cases and caused by *Plasmodium vivax, Plasmodium falciparum, Plasmodium ovale, Plasmodium malariae,* and *P. knowlesi* [6, 10, 13, 17, 21, 29]. *Plasmodium falciparum* was the most common species in imported cases from Africa [21], while *P. vivax* was more common in imported malaria cases from Asia, particularly among immigrants or workers from India, Indonesia, Myanmar, and Papua New Guinea [10, 21]. Studies from Sri Lanka and China reported occurrences of severe malaria in imported cases, with some fatalities attributed to *P. falciparum* and *P. knowlesi* [10, 21, 22].

Imported malaria cases are treated following standard regimens, which vary by country. For example, sulfadoxine–pyrimethamine and primaquine are used in some settings [32], whereas in France, piperaquine tetraphosphate–dihydroartemisinin or atovaquone–proguanil combinations are the standard. In Sri Lanka, treatment includes artemether, lumefantrine, and primaquine, with dihydroartemisinin–piperaquine used as a second-line therapy [10, 33]. In Greece, a 14-day treatment regimen combining chloroquine and primaquine effectively reduced malaria transmission within cluster areas [7, 8]. Similarly, Sri Lanka also used the same chloroquine–primaquine combination for mass treatment to control outbreaks and prevent reintroduction triggered by immigrants [19].

Prevention for imported malaria case

Three articles specifically discussed MDA interventions. Mass drug administration implemented in Greece and Sri Lanka has been effective in preventing local transmission.

The target population for MDA included migrant workers in Sri Lanka and the entire immigrant population in Greece [7, 8, 19]. In Greece, following MDA and subsequent follow-up over 22 months, no malaria cases were detected among immigrants, with MDA coverage reaching 87.3% [7]. MDA is population-based and aims to reduce the parasite reservoir, rather than treating individual diagnosed cases, with implementation in Sri Lanka also demonstrating success in preventing malaria reintroduction from immigrants originating from endemic areas [19].

A total of three studies focused specifically on chemopreventive interventions. Chemoprophylaxis or chemoprevention strategies are used to prevent malaria infection in individuals before exposure, particularly among travellers or high-risk populations [30]. This intervention is distinct from both case management and MDA and focuses on prevention at the individual level rather than treatment or mass coverage as implemented in China [31]. In France, chemoprophylaxis targeting military personnel deployed to endemic areas demonstrated high adherence, with no malaria cases reported upon their return [30]. Similarly, in China, forest workers receiving chemoprophylaxis achieved coverage up to 98.4% [31]. In contrast, chemoprophylaxis in Sri Lanka showed limited effectiveness and was deemed insufficient to prevent reintroduction [14].

Vector surveillance

A total of six studies focused specifically on vector investigation. Vector investigation is necessary for identifying the receptivity of malaria-free areas [4]. In Sri Lanka, vector investigation during outbreaks and re-establishment revealed high densities of *Anopheles culicifacies* [18], while in Shanghai, China, urban malaria transmission was linked to elevated vector population [21]. Mosquito vectors have been detected within a 50- m radius of index cases [17], and vector investigation zones sometimes extended from 2 to 10 km, as reported in Sri Lanka [18].

Given the resource-intensive nature of these activities, prioritization is required and typically based on factors such as household proximity to mosquito breeding sites, as practiced in Greece [7], or focused on areas with high vector density as seen in China [21]. In Singapore, the success of vector control efforts is measured by the reductions in mosquito capture rates [25].

Vector control

Six studies highlighted interventions targeting both larval and adult mosquito stages. Larval source management on Tekong Island, home to military training facilities, involved clearing and concreting drains and filling large permanent water bodies. This was supported by one round of adulticide fogging and 9 weekly *Bacillus thuringiensis israelensis* (*Bti*) applications, followed by twice-monthly treatments. These combined efforts reduced mosquito catch rates by over 94% compared to baseline [25].

Similarly, the French military implemented vector control measures including larval source management, personal protection, IRS, use of mosquito nets, and both larval and adult mosquito control, alongside chemoprophylaxis interventions [30]. These efforts effectively reduced vector density, successfully containing the outbreak and preventing further malaria transmission [25, 30]. Common vector control measures, implemented either independently or in combination, include IRS, larviciding, insecticide-treated nets, repellents, and fogging [17, 18, 24, 30, 31].

Other measures: health promotion, intersectoral collaboration and modelling

Health promotion is an integral component of strategies to control imported malaria. Three studies from China and Sri Lanka highlighted the importance of health promotion. These efforts primarily target local populations vulnerable to imported cases. In addition to the intervention previously mentioned, China also adopted education and health promotion to high risk groups from malaria high endemic regions (Africa, Southeast Asia) such as construction workers, loggers, and drivers: professional training: and cross-border collaboration with Myanmar [22, 24, 26]. Promotional tools include leaflets, posters, souvenirs, newspaper articles, television broadcasts, and social media campaigns aimed to improve healthcare-seeking behaviour [26]. Both China and Sri Lanka have engaged national and international health organizations to support malaria surveillance [6, 18, 26].

In the context of malaria control, health promotion and intersectoral collaboration have been shown to be essential components in sustaining community awareness, ensuring access to preventive measures, and strengthening surveillance systems [22, 25, 31]. A modelling study conducted by Makinde and Okusum showed that anti-malarial chemotherapy can reduce malaria infection and lower intervention costs. However, chemotherapy alone is not sufficient and must be integrated with other interventions to ensure effective prevention and reintroduction [32].

Discussion

This review highlighted the effective measures against persistent threat experiencing by all malaria-free and receptive countries. The effective control of imported malaria relies on robust surveillance systems, with intervention such as case detection, case management, health promotion, vector control, vector surveillance. These efforts must be sustained and targeted toward imported malaria cases, the environment, healthcare workers, and policymakers [4, 10, 18, 24–26].

This review found that case surveillance is the primary strategy for controlling imported malaria, which can be conducted through either active or passive case detections, with variations in implementation [15]. A study in China found that ACD is better than PCD [31], while MBS and PACD have also proven effective, as observed in Greece and Malaysia [8, 17]. Countries often adapt surveillance standards to suit their specific contexts, sometimes adopting methods from other nations, as seen in Thailand [34].

Case surveillance of imported malaria can be conducted at entry points, border areas, healthcare facilities, or through contact tracing [6, 29]. Controlling imported malaria at borders poses challenges due to differing malaria elimination statuses across regions. Several interventions to address border malaria include migration surveillance, chemoprophylaxis, MDA, and cross-border collaboration [6, 7, 12, 19, 23, 31]. The effectiveness of these interventions is generally enhanced when implemented in combination, although their impact requires ongoing evaluation and contextual adaptation [7, 14, 24, 29, 31].

Another challenge in managing imported malaria, particularly from Asia, involves the hypnozoite stage of *P. vivax*, which can remain undetected for months and cause relapses [29]. The estimated prevalence of asymptomatic and sub-microscopic malaria among imported cases is approximately 5.7% and 3–22%, respectively [16, 17]. These undetected reservoirs highlighted the need for sensitive diagnostic tools such as molecular techniques [6, 16, 27]. Reservoirs originating from imported cases can trigger local outbreaks [35].

The choice of diagnostic tools for imported malaria varies across countries, depending on available resources, capacity, and national policies. In Yinjiang, China, PCR is the primary diagnostic tool, with microscopy used for confirmation [24], whereas in Hainan, China, the sequence is reversed [31].

A major challenge in diagnosing malaria within elimination settings is ensuring the accurate identification of *Plasmodium* species by laboratory personnel. Limited practical exposure to malaria diagnosis can compromise accuracy. Nevertheless, with adequate training, laboratory staff can significantly improve microscopic diagnostic performance, thereby reducing the risk of misidentification—although molecular methods such as PCR remain superior in sensitivity and specificity [27, 31]. Misidentification under microscopy remains a concern, particularly due to morphological similarities between *P. malariae* and *P. knowlesi*, which underscore the need for molecular methods for confirmation [36].

Ensuring diagnostic accuracy requires high-quality diagnostic tools and adherence to strict accuracy standards, as demonstrated in China, which enforces a minimum diagnostic accuracy of 90% [22, 37]. Thus, continuous training and capacity building for laboratory personnel are essential components for maintaining diagnostic competence [11, 21, 27].

This review found that the speed of migration surveillance varies across countries. Adherence to surveillance protocols is crucial for preventing local transmission. Countries that have recently achieved malaria-free status typically maintain more responsive and efficient surveillance systems, while countries that have been malaria-free for longer may exhibit slower responses [12, 15, 26]. Faster surveillance correlates with the reduced risk of outbreaks and re-establishment, whereas delays in diagnosis increase the likelihood of malaria resurgence [12]. These disparities may stem from differences in laboratory staff's diagnostic competence, availability of diagnostic tools, and access to antimalarial treatments [29].

In parallel with migration surveillance, timely epidemiological investigations are vital for detecting potential transmission from index cases [7, 26]. Evidence from Sri Lanka shows that even a single imported case can trigger an outbreak and re-establishment [18], with one outbreak occurring up to 2 months after the index case was identified—an occurrence also reported in Malaysia [17]. If effectively managed and contained, outbreaks are typically remain small-scale, localized and resolves within 55–79 days [8, 24].

This review emphasized the importance of understanding the characteristics of imported malaria in determining effective control strategies. Migrants who trigger outbreaks and reintroductions are typically individuals or groups originating from malaria-endemic areas, or those with recent travel history to such areas [27, 31]. Most imported malaria cases are traced to endemic countries in Africa and Asia. Migrants from Africa are primarily immigrants and refugees who tend to settle in European countries [7, 11, 16]. In contrast, imported malaria cases from Asia predominantly come from East, West, South, and Southeast Asia [6, 10, 14, 20, 27]. Given the diverse origins and occupations of these migrants, strict monitoring is essential [21].

Imported malaria from Africa often involves clustered groups arriving and residing together, which enables active and sustained surveillance and intervention, particularly within refugee camps [7, 8]. Reported imported cases also include military personnel, loggers, and outdoor technicians [4, 17, 18]. In the case of military personnel, targeted surveillance and preventive measures such as chemoprophylaxis can be implemented within military barracks [7, 11, 16]. Several challenges need to be mitigated [29], including treatment adherence, availability of chemoprophylaxis, and detection of asymptomatic or sub-microscopic infections [4, 23, 29]. If left unmanaged, these factors can become sources of infections and lead to outbreaks and re-establishment of malaria transmission.

Only confirmed imported malaria or reintroduced malaria cases are treated with antimalarial drugs following national treatment guidelines [27]. Mass drug administration has been implemented in Greece, and Sri Lanka [7, 19]. However, the main drawback of MDA is its high cost, which requires careful consideration of location, target population, and malaria transmission patterns to maximize its effectiveness [7]. Post-treatment monitoring and parasitaemia evaluation are necessary to ensure parasite clearance and detect potential drug resistance [10]. Evidence in Greece reported a well-planned mass treatment is cost-effective compared to the economic burden of potential malaria transmission [7].

This review also highlights the role of health promotion in preventing outbreaks and in stopping reintroductions from progressing into re-establishment, as demonstrated in China and Sri Lanka [18, 26]. Health promotion had proven in reinforcing national surveillance systems and plays an important role in the malaria elimination process. In China, diverse promotional media—ranging from visual to audio—were utilized to support epidemiological investigation [26]. Intersectoral collaboration was identified as one of four key elements for managing imported cases [22]. This approach may offer a viable alternative to foster community support in achieving eliminating malaria.

Several countries have successfully controlled outbreaks and reintroductions, thereby preventing the re-establishment of transmission, including China, Greece, Sri Lanka, and Canada [8, 17, 18, 31]. These countries remain vigilant against outbreaks triggered by migrants from endemic areas, as seen in Sri Lanka, Malaysia [13, 17]. The risk of outbreaks and reintroductions (which may, in certain conditions, lead to re-establishment of transmission) is closely linked to the receptivity of a region; areas with higher receptivity are at greater risk [38]. High receptivity is typically associated with forested landscapes in Southeast Asia, favourable climate conditions for vector breeding, the presence of competent vectors, and the influx of imported cases [4, 17, 21, 28].

Inadequate control programmes, when combined with environmental suitability, vector presence, migrant populations, and high-risk behaviours, can lead to outbreaks or re-establishment of malaria transmission [17, 38]. Effective outbreak control strategies are essential, including the establishment of outbreak response teams and enhanced vector control through light traps, IRS, LLINs, and larvicides, as practiced in China, Sri Lanka, and Malaysia [17, 18, 21]. Environmental management should be prioritized in all receptive regions. Recommended measures such as establishing physical barriers between malaria patients and residential areas, reducing coastal water salinity, clearing vegetation, removing bush, and maintaining proper drainage systems, as practiced in Korea [4, 25]. Ultimately, integrating multiple control strategies and ensuring rapid and effective migration surveillance are crucial to preventing outbreaks, the reintroduction of imported cases, and the re-establishment of local transmission [12, 38]. Modelling studies are expected to help identify appropriate strategies and intervention integration tailored to the local context, in order to effectively predict outcomes for preventing reintroduction and sustaining control efforts [5, 32].

The primary limitation of this review lies in the predominance of retrospective observational studies, which were not specifically designed to the impact of interventions, innovations, or strategies for controlling imported malaria. Several articles lacked detailed information on control measures, limiting the ability to comprehensively assess the full scope of efforts undertaken to manage imported malaria.

Conclusion

The emergence of imported malaria poses a serious challenge for regions that have achieved malaria elimination. This review underscores the importance of integrated multiple strategies that target high- risk populations, affected communities, and environmental factors, alongside sustained intersectoral and international collaboration. The management of malaria importation must be adapted to the unique epidemiological and contextual conditions of each region. Looking ahead, it is essential to develop strategies capable of assessing regional vulnerability and receptivity to strengthen preparedness and response efforts.

Abbreviations

ACD	Active case detection
API	Annual parasite incidence
CDC	Central for disease control and prevention
G6PD	Glucose 6 phosphate dehydrogenase
ICT	Immunochromatographic test
IRS	Indoor residual spraying
KAP	Knowledge attitude practice
LLIN	Long-lasting insecticidal net
MBS	Mass blood survey
MDA	Mass drug administration
PACD	Proactive case detection
PCC	Population contents concepts
PCD	Passive case detection
PCR	Polymerase chain reaction
POR	Prevention of re-establishment

PRISMA	Preferred reporting items for systematic review and meta-analyses
RDT	Rapid diagnostic test
RACD/RCD	Reactive case detection
ScR	Scoping review
TLS	Three-layer survey
WHO	World health organization

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Author details
[1]Doctoral Programme, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia. [2]Department of Parasitologi, Faculty of Medicine, Universitas Islam Indonesia, Yogyakarta, Indonesia. [3]Center of Tropical Medicine, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia. [4]Department of Biostatistics, Epidemiology and Population Health, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia. [5]Geospatial Epidemiology Programme, Oxford University Clinical Research Unit, Jakarta, Indonesia. [6]Public Health Programme, Monash University Indonesia, Tangerang, Banten, Indonesia. [7]Department of Parasitology, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia.

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References

1. WHO. World malaria report 2023. Geneva: World Health Organization; 2023.
2. WHO. World malaria report 2024: addressing inequity in the global malaria response. Geneva: World Health Organization; 2024.
3. WHO. Malaria elimination: a field manual for low and moderate endemic countries. Geneva: World Health Organization; 2007.
4. Strickman D, Miller ME, Kelsey LL, Lee WJ, Lee KW, Kim HC, et al. Evaluation of the malaria threat at the multipurpose range complex, Yongp'yong, Republic of Korea. Mil Med. 1999;164:626–9.
5. Lu G, Zhang D, Chen J, Cao Y, Chai L, Liu K, et al. Predicting the risk of malaria re-introduction in countries certified malaria-free: a systematic review. Malar J. 2023;22:175.
6. Zeng XC, Sun XD, Li JX, Chen MN, Deng DW, Zhang CL, et al. Assessment of malaria control consultation and service posts in Yunnan, P. R. China. Infect Dis Poverty. 2016;5:102.
7. Tseroni M, Baka A, Kapizioni C, Snounou G, Tsiodras S, Charvalakou M, et al. Prevention of malaria resurgence in Greece through the association of mass drug administration (MDA) to immigrants from malaria-endemic regions and standard control measures. PLoS Negl Trop Dis. 2015;9:e0004215.
8. Tseroni M, Georgitsou M, Baka A, Pinaka O, Pervanidou D, Tsironi M, et al. The importance of an active case detection (ACD) programme for malaria among migrants from malaria endemic countries: the Greek experience in a receptive and vulnerable area. Int J Environ Res Public Health. 2020;17:4080.
9. WHO. Malaria Terminology. 2021. Geneva, World Health Organization; https://www.who.int/publications/i/item/9789240038400
10. Dharmawardena P, Rodrigo C, Mendis K, Gunasekera WMKTAW, Premaratne R, Ringwald P, et al. Response of imported malaria patients to antimalarial medicines in Sri Lanka following malaria elimination. PLoS ONE. 2017;12:e0188613.
11. Ndao M, Bandyyayera E, Kokoskin E, Gyorkos TW, MacLean JD, Ward BJ. Comparison of blood smear, antigen detection, and nested-PCR methods for screening refugees from regions where malaria is endemic after a malaria outbreak in Quebec, Canada. J Clin Microbiol. 2004;42:2694–700.
12. Chehab MA, Bala MO, Al-Dahshan A, Selim NA, Al-Romaihi HE, Al-Thani M, et al. Evaluation of the completeness and timeliness of national malaria surveillance system in Qatar, 2016. Cureus. 2018;10:1–10.
13. Wickramage K, Galappaththy GNL. Malaria burden in irregular migrants returning to Sri Lanka from human smuggling operations in West Africa and implications for a country reaching malaria elimination. Trans R Soc Trop Med Hyg. 2013;107:337–40.
14. Wickremasinghe AR, Wickremasinghe R, Herath HDB, Fernando SD. Should chemoprophylaxis be a main strategy for preventing re-introduction of malaria in highly receptive areas? Sri Lanka a case in point. Malar J. 2017;16:102.
15. Wang T, Zhou SS, Feng J, Oo MM, Chen J, Yan CF, et al. Monitoring and evaluation of intervals from onset of fever to diagnosis before "1-3-7" approach in malaria elimination: a retrospective study in Shanxi Province, China from 2013 to 2018. Malar J. 2019;18:235.
16. Fradejas I, Rubio JM, Martín-Díaz A, Herrero-Martinez JM, Ruiz-Giardin JM, Rojo-Marcos G, et al. Prevalence of submicroscopic malaria infection in immigrants living in Spain. Malar J. 2019;18:242.
17. Naserrudin NA, Aziz EIA, Aljet E, Mungunji G, Tojo B, Jeffree MS, et al. High incidence of asymptomatic cases during an outbreak of *Plasmodium malariae* in a remote village of Malaysian Borneo. PLoS Negl Trop Dis. 2021;15:e0009450.
18. Karunasena VM, Marasinghe M, Koo C, Amarasinghe S, Senaratne AS, Hasantha R, et al. The first introduced malaria case reported from Sri Lanka after elimination: implications for preventing the re-introduction of malaria in recently eliminated countries. Malar J. 2019;18:210.
19. Marasinghe MM, Karunasena VM, Seneratne AS, Herath HDB, Fernando D, Wickremasinghe R, et al. Mass radical treatment of a group of foreign workers to mitigate the risk of re-establishment of malaria in Sri Lanka. Malar J. 2020;19:346.
20. Dharmawardena P, Premaratne R, Mendis K, Wickemasinghe R, Rodrigo C, Harintheran A, et al. Effectiveness of passive case detection for imported malaria in a hospital setting in Sri Lanka during the prevention of re-introduction phase of malaria. Int Health. 2018;11:64–70.
21. Dai S, Zhu M, Wu H, Zhang Y, Wang Z, Zhang C, et al. From malaria elimination to post-elimination: a 10-year surveillance data study in Shanghai. Malar J. 2021;20:199.
22. Zhang T, Xu X, Liu B, Wang D, Ye X, Jiang J, et al. Establishing and applying an adaptive framework for imported malaria: a field practice in Anhui Province, China from 2012 to 2022. BMC Public Health. 2024;24:695.
23. Yeom JS, Ryu SH, Oh S, Choi DY, Song KJ, Oh YH, et al. Evaluation of anti-malarial effects of mass chemoprophylaxis in the Republic of Korea Army. J Korean Med Sci. 2005;20:707.
24. Lin Z-R, Li S-G, Sun X-D, Guo X-R, Zheng Z, Pian H-R, et al. Effectiveness of joint 3 + 1 malaria strategy along China-Myanmar cross border areas. BMC Infect Dis. 2021;21(1):1246.
25. Lee VJ, Ow S, Heah H, Tan MY, Lam P, Ng LC, et al. Elimination of malaria risk through integrated combination strategies in a tropical military training Island. Am Soc of Trop Med Hyg. 2010;82:1024–9.
26. Cao Y, Lu G, Cotter C, Wang W, Yang M, Liu Y, et al. Improving the surveillance and response system to achieve and maintain malaria elimination:

a retrospective analysis in Jiangsu Province, China. Infect Dis Poverty. 2022;11:20.

27. Herdiana H, Irnawati I, Coutrier FN, Munthe A, Mardiati M, Yuniarti T, et al. Two clusters of *Plasmodium knowlesi* cases in a malaria elimination area, Sabang Municipality, Aceh, Indonesia. Malar J. 2018;17:186.
28. Pramestuti N, Kesuma AP, Wijayanti SPW, Pribadi L. Prevention of indigenous malaria cases by strengthening migration surveillance at village level in Purbalingga Regency, Central Java Province, Indonesia. WHO South-East Asia J Pub Health. 2022;11:87–92.
29. Fernando SD, Booso R, Dharmawardena P, Harintheran A, Raviraj K, Rodrigo C, et al. The need for preventive and curative services for malaria when the military is deployed in endemic overseas territories: a case study and lessons learned. Mil Med Res. 2017;4:19.
30. Migliani R, Pradines B, Michel R, Aoun O, Dia A, Deparis X, et al. Malaria control strategies in French armed forces. Travel Med Infect Dis. 2014;12:307–17.
31. Li Y, Huang Y, Chen R, Huang W, Xu H, Ye R, et al. An innovative three-layer strategy in response to a quartan malaria outbreak among forest goers in Hainan Island, China: a retrospective study. Infect Dis Poverty. 2022;11:97.
32. Makinde OD, Okosun KO. Impact of chemotherapy on optimal control of malaria disease with infected immigrants. Biosystems. 2011;104:32–41.
33. Mendis K, Fernando D, Ranaweera P, Gunasekera K, Fernando T, Newby G, et al. Preventing the re-establishment of malaria during the COVID-19 pandemic in Sri Lanka: implications for health security. Malar J. 2024;23:254.
34. Areechokchai D. Predicting factors for malaria reintroduction and a multifactorial approach to prevent malaria outbreaks in the malaria-free areas. Outbreak Surveill Investig Response (OSIRJ). 2024;17:120–7.
35. Jiram AI, Ooi CH, Rubio JM, Hisam S, Karnan G, Sukor NM, et al. Evidence of asymptomatic submicroscopic malaria in low transmission areas in Belaga district, Kapit division, Sarawak, Malaysia. Malar J. 2019;18:156.
36. Amir A, Cheong FW, De Silva JR, Liew JWK, Lau YL. *Plasmodium knowlesi* malaria: current research perspectives. Infect Drug Resist. 2018;11:1145–55.
37. WHO. 2017. A framework for malaria elimination. Geneva, World Health Organization; https://iris.who.int/handle/10665/254761
38. WHO. Prevention of re-establishment of malaria transmission. Geneva: World Health Organization; 2025.

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