

Vital Surveillances

Epidemiological Characteristics of Imported Malaria Cases Along the China–Myanmar Border — Yunnan Province, China, 2021–2025

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ABSTRACT

Introduction: In this study, the epidemiological characteristics of imported malaria cases (IMCs) along the China–Myanmar border in Yunnan Province (CMBYP) between 2021 and 2025 were analyzed, to provide a scientific basis for formulating effective measures to control imported malaria, prevent re-transmission, and consolidate malaria elimination achievements.

Methods: Individual data were collected from the National Notifiable Disease Reporting System for 2021–2025. The temporal, spatial, and demographic distributions of malaria cases, along with *Plasmodium* species, case classification, source of infection, and timeliness of medical treatment, were analyzed to describe the epidemiological characteristics.

Results: A total of 1,602 IMCs were reported in the CMBYP, with *Plasmodium vivax* accounting for 98.50% (1,578/1,602) of the cases. Of these, 75.97% (1,217/1,602) originated in Myanmar. The number of cases peaked between May and July. Demographically, 75.09% (1,203/1,602) of the patients were male, with a male-to-female ratio of 3.02:1. All time intervals including those from onset to initial diagnosis and from the initial medical visit to malaria diagnosis were shorter in 2021–2022 than in 2023–2025. Additionally, 84.14% (1,348/1,602) of patients were correctly diagnosed at the initial medical visit.

Conclusion: Summer is a critical period for the prevention and control of imported malaria. Strengthening case surveillance and vector control is essential for preventing importation and introduced transmission. There was an increasing trend in the number of IMCs, suggesting a potentially increased risk of transmission. However, a comprehensive assessment requires integration of malaria epidemic

data from Myanmar. Malaria case surveillance is the core activity for malaria elimination, and for preventing the re-establishment of local malaria transmission.

Malaria is a severe threat to public health worldwide. The *World Malaria Report 2025* estimated that there were >280 million malaria cases and over 600,000 deaths worldwide in 2024 (1). Malaria, once highly prevalent in China, significantly endangers the health of the general population. After >70 years of sustained efforts, China eliminated malaria, and it was officially certified by the World Health Organization in 2021 (2). Nevertheless, the China–Myanmar border in Yunnan Province (CMBYP) remains the most challenging area for malaria control in China because of its unique geographical location, frequent cross-border movement, lack of natural border barriers, and an environment conducive to vector breeding and malaria transmission (3). To develop targeted prevention and control strategies, prevent introduced transmission, and sustain elimination achievements in border areas, the epidemiological characteristics of imported malaria cases (IMCs) along the CMBYP between 2021 and 2025 were analyzed.

METHODS

Individual malaria data from 18 counties (cities) along the CMBYP were collected via the National Notifiable Disease Reporting System (NNDRS) between 2021 and 2025. The temporal, spatial, and demographic distribution of malaria cases, together with data on *Plasmodium* species, case classification [indigenous^{*}, imported[†], or other

* Indigenous case: a malaria case that resulted in sustained local transmission over time (beyond the first generation), indicating an established transmission cycle.

† Imported case: a malaria infection acquired outside the area/country and diagnosed after entry/return; local mosquito transmission is not implied.

(relapse[§] or introduced[¶])] (4), source of infection, and timeliness of medical treatment, were analyzed to explore the characteristics of IMCs. Data from Hong Kong, Macao, and Taiwan were not included. Also, data from foreign nationals were included. Clinically diagnosed cases^{**} and confirmed cases^{††} were included in the analysis. The data were organized and analyzed using WPS (version 12.1.0.26895, Kingsoft Corp., Zhuhai, China) and SPSS (version 26.0, IBM Corp., New York, US). Time-interval data were compared using the Kruskal-Wallis H test, and annual variation was assessed using the chi-square (χ^2) test for trend, with $P<0.05$ considered to be statistically significant. Anonymized routine surveillance data were used, and they were exempt from ethical review.

RESULTS

A total of 1,602 malaria cases within the CMBYP were recorded in the NNDRS between 2021 and 2025, all of which were IMCs. One death was reported in 2025^{§§}. The IMCs occurred predominantly among Chinese people ($n=1,410$, 88.01%). Among these, 1,601 (99.94%) were confirmed, and in one (0.06%) case there was a clinical diagnosis. The IMCs included *P. vivax* ($n=1,578$, 98.50%), *P. falciparum* ($n=20$, 1.25%), *P. ovale* ($n=3$, 0.19%), and *P. malariae* ($n=1$, 0.06%). Over the previous five years, except for a decrease in 2022, case numbers increased annually, with a statistically significant trend (χ^2 , 1,525.85; $P<0.01$) (Figure 1).

The IMCs originated in 14 countries across two

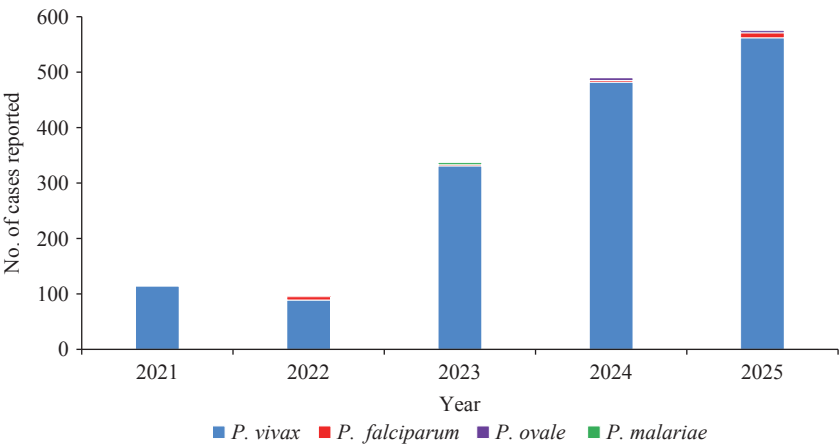


FIGURE 1. Imported malaria cases in counties along the China–Myanmar border in Yunnan Province (2021–2025). Abbreviation: *P. vivax*=*Plasmodium vivax*; *P. falciparum*=*Plasmodium falciparum*; *P. ovale*=*Plasmodium ovale*; *P. malariae*=*Plasmodium malariae*.

TABLE 1. Distribution of regions of infection among the imported malaria cases reported along the China-Myanmar border in Yunnan Province (2021–2025).

Continent	Country	<i>P. vivax</i>	<i>P. falciparum</i>	<i>P. ovale</i>	<i>P. malariae</i>	Subtotal
Africa	12	1	17	3	1	22
Asia	2	1,577	3	0	0	1,580
Total	14	1,578	20	3	1	1,602

Abbreviation: *P. vivax*=*Plasmodium vivax*; *P. falciparum*=*Plasmodium falciparum*; *P. ovale*=*Plasmodium ovale*; *P. malariae*=*Plasmodium malariae*.

[§] Relapse case: a malaria case caused by reactivation of hypnozoites of previously acquired *P. vivax* or *P. ovale*.
[¶] Introduced case: a first generation, locally acquired malaria infection in which transmission occurs via local *Anopheles* mosquitoes infected after feeding on an imported case (i.e., the index infection is imported, but the subsequent case is locally transmitted).
^{**} Clinically diagnosed case: A cases with typical or atypical clinical symptoms, with a history of an overnight stay in malaria-endemic areas during the transmission season or a blood transfusion in the preceding 14 days.
^{††} Confirmed case: a clinically diagnosed case that is confirmed as positive by microscopy, rapid diagnostic test, or a polymerase chain reaction assay.
^{§§} This patient was infected with *P. falciparum*. The patient was in critical condition upon entry and developed multiple organ failure. On entering China from Myanmar, the patient immediately received antimalarial and symptomatic treatments. The patient died on the second day after entry.

TABLE 2. Distribution of imported malaria cases by counties along the China-Myanmar border in Yunnan Province (2021–2025).

County (city)	<i>P. vivax</i>	<i>P. falciparum</i>	<i>P. ovale</i>	<i>P. malariae</i>	Subtotal
Yingjiang	879	2	0	0	881
Tengchong	227	2	2	1	232
Longchuan	135	0	0	0	135
Ruili	127	0	0	0	127
Mangshi	81	5	1	0	87
Gengma	33	2	0	0	35
Cangyuan	34	0	0	0	34
Zhenkang	30	0	0	0	30
Longling	18	0	0	0	18
Mengla	2	5	0	0	7
Jinghong	3	2	0	0	5
Menglian	3	1	0	0	4
Lushui	3	1	0	0	4
Menghai	1	0	0	0	1
Fugong	1	0	0	0	1
Langcang	1	0	0	0	1
Total	1,578	20	3	1	1,602

Abbreviation: *P. vivax*=*Plasmodium vivax*; *P. falciparum*=*Plasmodium falciparum*; *P. ovale*=*Plasmodium ovale*; *P. malariae*=*Plasmodium malariae*.

continents (Asia and Africa). Of these, IMCs from Asia ($n=1,580$, 98.63%) originated in two countries (Myanmar and Laos), whereas IMCs from Africa ($n=22$, 1.37%) originated in 12 countries. Most IMCs originated in Myanmar ($n=1,217$, 75.97%) (Table 1).

Overall, 16 counties, except for Gongshan and Ximeng, reported IMCs. Yingjiang County ($n=881$, 54.99%), Tengchong City ($n=232$, 14.48%), Longchuan County ($n=135$, 8.43%), and Ruili City ($n=127$, 7.93%) had the highest numbers of IMCs. These four counties (cities) accounted for 85.83% (1,375/1,602) of all IMCs (Table 2).

The temporal distribution showed that IMCs were reported monthly between 2021 and 2025 (2–117 cases/month), peaking between May and July. Cases during these months accounted for 48.56% (778/1,602) of all cases. There were 1,203 (75.09%) IMCs in males and 399 (24.91%) in females, with a sex ratio of 3.02:1. The age at onset ranged from nine months to 87 years, mainly among adults aged 21–50 years ($n=1,022$, 63.80%). The travel purposes were labor ($n=659$, 52.93%), visiting relatives or friends ($n=297$, 23.61%), other purposes ($n=151$, 12.13%), business ($n=111$, 8.91%), tourism ($n=20$, 1.61%), and official business ($n=10$, 0.80%). Among cases with "other" travel purposes, the majority ($n=125$, 82.78%)

were Myanmar residents, primarily visiting relatives or for employment.

The onset to initial diagnosis interval ranged from zero to 18 days [median, two days; interquartile range (IQR), three days], with 70.47% ($n=1,129$) of patients seeking care within three days of symptom onset. The initial visit to diagnosis interval ranged from zero to 10 days, with a median and IQR of zero days; 77.97% ($n=1,249$) of the cases were confirmed on the day of the initial consultation, and 89.45% ($n=1,433$) received a definitive diagnosis within two days. The diagnosis-to-reporting interval ranged from zero to four days (median, one day; IQR, one day), with almost all cases ($n=1,600$, 99.88%) reported within one day of diagnosis. The epidemiological survey completion interval ranged from zero to 239 days (median, two days; IQR, two days), with an 83.46% (1,337/1,602) completion rate within three days. Temporal trends across the five-year study period were assessed using the Kruskal–Wallis H test, which revealed statistically significant differences for all four intervals ($H=10.78$, 11.11, 71.39, and 466.36, respectively; all $P<0.05$). In addition, pairwise comparisons showed that all intervals were significantly shorter in 2021–2022 than in 2023–2025 ($U=125$, 742.50, 131,948.50, 115,313.00, and 123,525.00,

respectively; all $P < 0.01$).

Most patients ($n=1,348$, 84.14%) were diagnosed with malaria at their first visit, with the majority of the diagnoses being made at medical centers and CDCs at the county level or below ($n=1,297$, 96.22%). In contrast, 254 patients (15.86%) were initially diagnosed with other conditions, most frequently at township health centers or village clinics ($n=129$, 50.79%), followed by county-level medical centers or the CDC ($n=60$, 23.62%), and individual practitioners ($n=41$, 16.14%). Regarding reporting institutions, the IMCs were primarily reported by county-level medical institutions ($n=794$, 49.56%), township health centers ($n=649$, 40.51%), and prefecture-level medical institutions ($n=50$, 3.12%).

DISCUSSION

The predominance of *P. vivax* infections among IMCs in the CMBYP reflects the provincial case composition, but it diverges from the national profile. The high relapse potential of vivax malaria, together with the broad distribution of competent vectors and persistent control challenges, renders this region particularly vulnerable to introduced transmission following IMCs. The demographic distributions of sex and age were comparable to national figures (5–6). A distinct mid-year incidence peak, concurrent with maximal vector activity, underscores summer as a pivotal period for intervention. Reinforced case surveillance and vector control measures are imperative to prevent the re-establishment of local transmission. Notably, the majority of cases involved young to middle-aged males, with occupational labor and family visitation as the predominant travel motives. These observations suggest that targeted prevention strategies should be directed towards migrant workers returning from endemic areas and cross-border family visitors in the CMBYP, with an emphasis on improving malaria literacy and facilitating prompt medical consultation among these high-risk cohorts.

Over the 2021–2025 period, the accuracy of initial diagnoses for reported malaria cases was $>80\%$, closely aligning with the provincial mean. Initial misdiagnoses were most frequently documented at township health centers or village clinics, county-level medical facilities or CDCs, and individual practitioner offices. To reinforce malaria prevention and control in Yunnan Province, strategic priority should be assigned to

upgrading diagnostic capabilities at primary-level facilities and rectifying deficiencies in case diagnosis and treatment. Concurrently, structured training programs in malaria recognition and clinical management should be directed towards individual practitioners, with the goal of refining diagnostic judgment, and reducing the incidence of misdiagnosis and underdiagnosis.

The difference in the time intervals from onset to initial diagnosis and from initial diagnosis to definitive diagnosis is of great significance for public health (7). In the present study, it has been shown that the intervals between onset and initial diagnosis, and between initial diagnosis and confirmation, varied significantly across 2021–2025. Greater than 70% of the patients sought medical attention within three days of onset, and $>75\%$ were diagnosed on the day of the initial visit. These findings indicate that the diagnostic pathway in the CMBYP is efficient, facilitating early detection of cases, prompt administration of treatment, and effective interruption of transmission. The epidemiological investigation completion rate within three days was 83.46%, which is lower than that reported for Guangzhou City (8). The marked reduction in the three-day completion rate in 2023 was likely to be associated with the rollout of the new Parasitic Disease Prevention and Control Information Management System in September 2023. Additionally, the prolongation of all four time-intervals during 2023–2025, relative to 2021–2022, may reflect the combined effects of eased pandemic-related policies and decreased public vigilance towards fever-associated conditions in the post coronavirus disease 2019 era.

Yunnan Province is in the southwestern region of China, with a border of 4,060 km. It has 25 border counties in states (cities) bordering Myanmar, Laos, and Vietnam (3), including 18 counties bordering Myanmar. As a country with a high malaria burden, Myanmar has relatively poor public health infrastructure, slower economic development, and suitable conditions for malaria transmission. In 2024, the cumulative number of reported malaria cases increased by 238.04% compared to that in 2019, with cases mainly concentrated in the Thailand-Myanmar and China-Myanmar border areas (9). Since 2023, Yunnan Province has ranked first nationwide in reported malaria cases. From 2021 to 2025, 84% of malaria cases in the province originated from the CMBYP, with Yingjiang County, Tengchong City,

Longchuan County, and Ruili City reporting the highest numbers. Laiza and nearby areas in Myanmar, bordering Yingjiang County, were identified as the primary malaria hotspots in the border regions of Yunnan Province, China. The incidence rate of malaria in Kachin State in 2024 increased by 24.53 times compared with that in 2019, indicating a severe epidemic (10). A combination of these factors has led to a sustained and increasing risk of malaria transmission in the CMBYP.

To reduce imported malaria and prevent re-establishment of transmission, the "3+1" strategy was used to strengthen malaria surveillance, respond rapidly to imported malaria, and enhance cross-border collaboration with neighboring countries (11–12). To date, the province has achieved 10 consecutive years with no re-transmission of imported cases, and six consecutive years with no clustered cross-border imported malaria outbreak (13). However, after malaria elimination, some regions have shown declining attention towards malaria prevention and control (14). There is a perception that "malaria has specific therapeutics, rarely causes death, and will not lead to serious incidents" (15), resulting in insufficient staffing, funding, and material support for malaria control and prevention.

To further consolidate malaria elimination achievements in the China-Myanmar border areas, and to strengthen the foundations for preventing importation and transmission, all levels of government should establish "strictly preventing importation and transmission, consolidating malaria elimination achievements" as an annual work goal, and establish a normalized work mechanism; conversely, preferential support for border areas should be increased, with key guarantees in policy formulation, funding support, resource allocation, and other aspects, to support the prevention and control of introduced transmission. In addition, malaria case surveillance is the core activity for malaria elimination and prevention of the re-establishment of local malaria transmission, with laboratory diagnosis as the fundamental tool. This requires a medical-facility-based malaria case detection system supported by prompt CDC investigation and response, as well as effective communication and coordination across public and private hospitals, clinics, drug outlets, and pharmacies.

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