

Imported Malaria Cases — China, 2012–2018

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ABSTRACT

Introduction: In 2017, no indigenous malaria cases were reported in China, but imported malaria was a challenge for the elimination program. This study analyzed the status and trends of imported malaria in China from 2012 to 2018 to provide evidence for further strategies and adjustments to current interventions.

Methods: Data on individuals were collected from the Parasitic Diseases Information Reporting Management System (PDIRMS) from 2012 to 2018. *Plasmodium* species, case classification, temporal distribution, spatial distribution, and source of imported cases were analyzed to investigate imported malaria characteristics.

Results: In total, 21,376 malaria cases were recorded in the PDIRMS from 2012 to 2018. Among them, 20,938 (98.0%) cases were imported malaria cases (IMCs). The number and proportion of IMCs increased from 2012 (n=2,474, 91.0%) to 2018 (n=2,511, 99.7%). IMCs consisted of 13,510 (64.5%) *P. falciparum*, 4,803 (22.9%) *P. vivax*, 1,725 (8.2%) *P. ovale*, 376 (1.8%) *P. malariae*, 2 (0.01%) *P. knowlesi*, 348 (1.7%) mixed infections, and 174 (0.8%) clinically-diagnosed cases. The proportion of imported *P. falciparum* cases increased from 2012 (n=1403, 57.4%) to 2018 (n=1655, 66.0%), while imported *P. vivax* cases showed a decreasing trend from 2012 (n = 901, 43.7%) to 2018 (n=352, 14.0%). IMCs were mainly reported in Yunnan (n=2,922, 14.0%), Guangxi (n=2,827, 13.5%), and Jiangsu (2,067, 9.9%). IMCs were reported throughout the entire year, and the highest number of IMCs was reported in June 2013. IMCs originated from 67 countries from 4 continents, and the largest proportion were from Myanmar (n=3,081, 14.7%) and Ghana (n=2,704, 12.9%).

Conclusion and Implications for Public Health Practice: The total number of IMCs increased in

China. Therefore, two actions are needed to continue the elimination of malaria in China: prevent re-establishment caused by imported *P. vivax* because *Anopheles sinensis* is still widely distributed; and ensure timely diagnosis and appropriate treatment to avoid fatal cases caused by imported *P. falciparum*.

INTRODUCTION

China has succeeded in controlling indigenous malaria and has reached milestones towards malaria elimination since the National Malaria Elimination Action Plan has launched in 2010 (1–3). In 2017, for the first time, no indigenous cases were reported in China (4). However, with increasing globalization, larger numbers of people go to or return from malaria endemic areas and present challenges to malaria elimination in China (5).

Imported malaria cases (IMCs) may increase risks in malaria-free localities where *Anopheles* mosquitoes still exist. In addition, severe malaria infections caused by *Plasmodium falciparum* are catastrophic if diagnosis and treatment are not timely.

In 2012, the Parasitic Diseases Information Reporting Management System (PDIRMS) was set up to determine whether every case was indigenous or imported. Therefore, the objective of this study was to characterize the epidemiological status and trends of IMCs from 2012 to 2018 to provide evidence-based data to support the adjustment of appropriate strategies and activities towards the achievement of malaria elimination not only in China but also in other countries with similar elimination processes.

METHODS

Data from 31 provincial-level administrative divisions (PLADs) were collected via the PDIRMS from 2012 to 2018 and carefully reviewed. *Plasmodium* species, case classification [indigenous*, imported†,

* Indigenous case: a case contracted locally with no evidence of importation and no direct link to transmission from an imported case. In this study, an indigenous case refers to malaria acquired by mosquito transmission in the People's Republic of China.

† Imported case: a malaria case or infection in which the infection was acquired outside the area in which it was diagnosed. Here, it refers to the patient who acquired the illness from a known malaria-prevalent region outside the People's Republic of China.

or other (induced[§], introduced[¶], relapse^{**} or recrudescence^{††}), and source of imported cases were analyzed to explore the characteristics of IMCs. Clinically-diagnosed cases^{§§} and laboratory-confirmed cases^{¶¶} were included in this analysis. Data from Hong Kong, Macao, and Taiwan were excluded from the study. Moreover, data from foreign nationals were not concluded. Statistical analysis was performed using the chi-square test for trends by software SPSS (version 21.0, IBM Corp., New York, US), and $p < 0.05$ was considered statistically significant.

RESULTS

In total, 21,376 malaria cases were recorded in the PDIRMS from 2012 to 2018. Among them, 20,938 (98.0%) cases were IMCs. The number and proportion of IMCs increased from 2012 (n=2,474, 91.0%) to 2018 (n=2,511, 99.7%) with statistical significance (evaluated by chi-square test for trends, $\chi^2 = 435.423$, $p < 0.001$). IMCs consisted of 20,764 laboratory-confirmed cases and 174 clinically-diagnosed cases. The laboratory-confirmed cases consisted of 13,510 (64.5%) *P. falciparum* cases, 4,803 (22.9%) *P. vivax* cases, 1,725 (8.2%) *P. ovale* cases, 376 (1.8%) *P. malariae* cases, 2 (0.01%) *P. knowlesi* cases, 348 (1.7%) mixed infection cases (Table 1). Among these cases, the

proportion of imported *P. falciparum* cases increased from 2012 (n=1,403, 57.4%) to 2018 (n=1,655, 66.0%), while imported *P. vivax* cases decreased from 2012 (n=901, 43.7%) to 2018 (n=352, 14.0%). In addition, imported *P. malariae* and *P. ovale* cases also increased during the same timeframe. In 2012, the proportion of *P. malariae* and *P. ovale* cases was 2.3% (n=56), while in 2018, this proportion peaked at 18.0% (n=453). Most IMCs were male (n=19,877, 94.9%), and 1,061 cases (5.1%) were female. The highest number of IMCs was observed in the age group of 46 to 50 years, and most IMCs occurred in migrant workers (n=14,300, 68.3%).

IMCs were mainly reported in the PLADs of Yunnan (n=2,922, 14.0%), Guangxi (n=2,827, 13.5%), and Jiangsu (n=2,067, 9.9%) (Table 2). The distribution of IMCs broadened with cases reported in 618 counties in 2012 and 688 counties in 2018. The temporal distribution showed that IMCs were reported throughout the entire year, and the highest number of IMCs was reported in June 2013 (n=857) (Figure 1).

IMCs originated from 67 countries from 4 continents, and among them, 16,720 cases (79.9%) originated from Africa, mainly central and western Africa, which accounted for 33.5% (n=7,007) and 32.5% (n=6,806) of all IMCs, respectively. IMCs from

TABLE 1. Clinically-diagnosed and laboratory-confirmed imported malaria cases in China (2012–2018).

Year	Subtotal	Laboratory-confirmed cases						Clinically-diagnosed cases
		<i>P. vivax</i>	<i>P. falciparum</i>	<i>P. ovale</i>	<i>P. malariae</i>	<i>P. knowlesi</i>	Mixed	
2012	2,474	901	1,403	56*	0	0	39	
2013	4,042	859	2,899	133	51	0	35	
2014	3,022	798	1,876	231	53	1	19	
2015	3,077	779	1,895	266	65	0	17	
2016	3,139	622	2,066	315	64	0	14	
2017	2,672	496	1,716	350	65	1	9	
2018	2,511	348	1,655	374	78	0	5	
Total	20,938	4,803	13,510	1,725	376	2	174	

* The number of imported *P. ovale* and *P. malariae* was not counted separated, so herein we provide the total number of *P. ovale* and *P. malariae*.

§ Induced case: a case in which the origin of the illness can be traced to a blood transfusion or other form of parenteral inoculation of the parasite but not to transmission by a natural mosquito-borne inoculation.

¶ Introduced case: a case contracted locally with strong epidemiological evidence linking it directly to a known imported case (first-generation local transmission).

** Relapse case: a malaria case attributed to activation of hypnozoites of *P. vivax* or *P. ovale* acquired previously.

†† Recrudescence case: recurrence of asexual parasitaemia of the same genotype(s) that caused the original illness due to incomplete clearance of asexual parasites after antimalarial treatment.

§§ Clinically diagnosed case: an individual with malaria-related symptoms (fever [axillary temperature ≥ 37.5 °C], chills, severe malaise, headache, or vomiting) at the time of examination.

¶¶ Laboratory-diagnosed case: a clinical case confirmed by microscopy, polymerase chain reaction, or rapid diagnostic tests in the laboratory.

TABLE 2. Imported malaria cases in 31 provincial-level administrative divisions (PLADs) in China (2012–2018).

PLADs	Total cases	Imported cases		Proportion of imported cases (%) in the whole country
		Number	Proportion (%)	
Yunnan	3,285	2,922	88.9	14.0
Guangxi	2,828	2,827	99.9	13.5
Jiangsu	2,070	2,067	99.9	9.9
Sichuan	1,697	1,697	100.0	8.1
Henan	1,285	1,285	100.0	6.1
Shandong	1,283	1,282	99.9	6.1
Zhejiang	1,241	1,241	100.0	5.9
Guangdong	1,038	1,035	99.7	4.9
Hunan	969	964	99.5	4.6
Hubei	884	875	99.0	4.2
Anhui	876	845	96.5	4.0
Fujian	637	637	100.0	3.0
Beijing	561	561	100.0	2.7
Shannxi	424	424	100.0	2.0
Liaoning	355	353	99.4	1.7
Hebei	323	323	100.0	1.5
Jiangxi	304	304	100.0	1.5
Shanghai	284	284	100.0	1.4
Chongqing	209	209	100.0	1.0
Gansu	162	162	100.0	0.8
Guizhou	150	150	100.0	0.7
Jilin	105	105	100.0	0.5
Shanxi	93	93	100.0	0.4
Hainan	81	80	98.8	0.4
Tianjin	62	62	100.0	0.3
Heilongjiang	41	41	100.0	0.2
Xinjiang	37	37	100.0	0.1
Ningxia	29	29	100.0	0.1
Inner Mongolia	19	19	100.0	0.1
Qinghai	14	14	100.0	0.1
Tibet	30	9	30.0	0.0
Total	21,376	20,936	97.9	100.0

Africa in this time period showed an increasing trend with 58.8% in 2012 (n=1,454) and 90.4% in 2018 (n=2,470). The imported *P. falciparum* cases from Africa also showed an increasing trend. In 2012, 32 African countries reported 1,177 *P. falciparum* cases, while in 2018, 35 African countries reported 1,641 *P. falciparum* cases. The cases imported from Africa were mainly from Ghana (n=2,704, 12.9%), Angola (n=2,085, 10.0%), and Nigeria (n=1,939, 9.3%) (Table 3).

The cases from another major infection source, namely, Southeast Asia, gradually declined. In this area, 3,999 cases (19.1%) were reported in 2012-2018 with a 77.1% decrease from 2012 (n=955) to 2018 (n=219). In Myanmar, the major source of imported cases in Southeast Asia, the number of *P. vivax* cases greatly decreased. In 2012, there were 554 *P. vivax* cases imported from Myanmar, accounting for 22.4% of the IMCs in the same year. In 2018, however, there were only 154 cases imported from Myanmar,

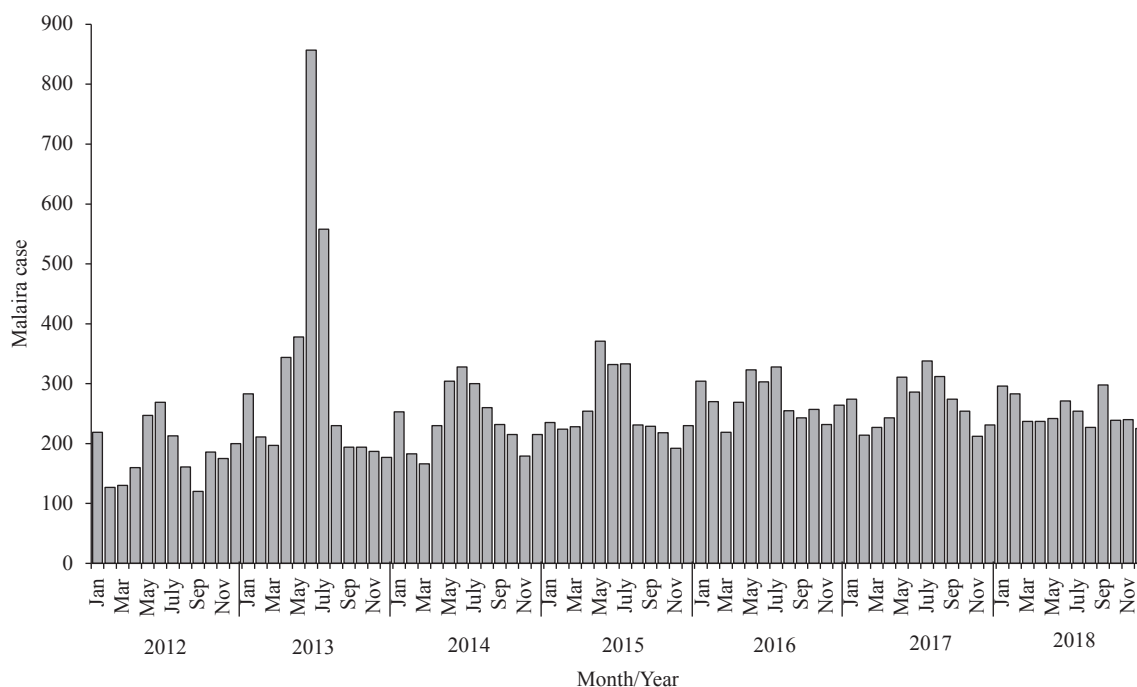


FIGURE 1. Temporal distribution of imported malaria cases in China (2012–2018).

TABLE 3. Source of imported cases reported in China (2012–2018).

Regions	Country	2012	2013	2014	2015	2016	2017	2018	Total
Africa		1,454	3,243	2,295	2,487	2,689	2,282	2,270	16,720
Southeast Africa		196	311	380	457	541	436	395	2,716
	Ethiopia	38	62	118	150	148	113	95	724
	Mozambique	22	48	68	75	84	103	104	504
	Uganda	16	28	28	53	139	66	41	371
	Tanzania	13	34	41	52	49	46	58	293
	Sudan	63	72	44	44	7	15	10	255
	Zambia	17	37	42	48	47	30	33	254
	Kenya	7	6	11	9	14	23	13	83
	Malawi	9	9	10	6	11	13	13	71
	Madagascar	5	3	9	9	4	8	7	45
	South Sudan	0	1	2	3	20	9	10	45
	Rwanda	2	2	5	6	14	5	5	39
	Zimbabwe	2	3	2	1	2	3	0	13
	Djibouti	0	0	0	0	1	2	5	8
	Egypt	2	5	0	0	1	0	0	8
	Eritrea	0	0	0	1	0	0	1	2
	Somalia	0	1	0	0	0	0	0	1
West Africa		641	1,870	879	723	828	950	915	6,806
	Ghana	235	1349	188	172	241	347	172	2,704
	Nigeria	207	225	341	283	273	286	324	1,939
	Guinea	58	75	64	98	72	80	129	576
	Côte d'Ivoire	18	16	41	64	104	97	127	467

TABLE 3. (Continued)

Regions	Country	2012	2013	2014	2015	2016	2017	2018	Total
	Liberia	44	86	88	34	39	61	56	408
	Sierra Leone	43	55	53	34	43	44	63	335
	Benin	5	22	33	10	17	9	12	108
	Togo	2	24	50	9	6	4	10	105
	Mali	17	14	11	8	10	13	11	84
	Burkina Faso	6	3	8	6	3	4	3	33
	Niger	0	0	0	1	17	4	3	25
	Senegal	5	1	0	2	3	1	4	16
	Mauritania	1	0	2	0	0	0	0	3
	Gambia	0	0	0	2	0	0	1	3
Central Africa		550	1,038	1,015	1,283	1,292	882	947	7,007
	Angola	151	437	272	416	410	192	207	2,085
	Equatorial Guinea	247	300	287	272	185	132	115	1,538
	Cameroon	17	101	175	248	242	190	159	1,132
	Democratic Republic of the Congo	47	64	118	175	244	151	236	1,035
	Republic of Congo	33	53	83	101	154	119	98	641
	Gabon	35	42	34	43	37	53	73	317
	Chad	11	36	38	25	9	13	30	162
	The Central African Republic	9	5	5	2	8	28	25	82
	Burundi	0	0	3	1	3	4	4	15
South Africa		11	21	17	12	14	9	5	89
	South Africa	11	20	15	12	13	8	5	84
	Namibia	0	1	1	0	1	1	0	4
	Comoros	0	0	1	0	0	0	0	1
North Africa		5	1	0	0	6	4	7	23
	Libya	3	0	0	0	5	3	6	17
	Algeria	2	1	0	0	1	1	1	6
Africa (Other regions)		51	2	4	12	8	1	1	79
Asia		955	774	706	566	420	359	219	3,999
Southeast Asia		906	736	674	548	392	291	192	3,739
	Myanmar	766	605	495	477	326	245	167	3,081
	Indonesia	36	71	142	35	27	18	7	336
	Laos	37	38	18	12	27	13	5	150
	Cambodia	57	19	9	17	6	14	11	133
	Vietnam	4	0	3	2	1	1	1	12
	Thailand	1	3	5	1	0	0	0	10
	Malaysia	2	0	2	2	2	0	0	8
The Philippines		0	0	2	3	0	1	6	
	Timor-Leste	3	0	0	0	0	0	0	3
East Asia		2	1	0	1	1	1	1	7
	Democratic People's Republic of Korea	1	1	0	1	1	0	0	4
	Republic of Korea	1	0	0	0	0	1	1	3

TABLE 3. (Continued)

Regions	Country	2012	2013	2014	2015	2016	2017	2018	Total
South Asia		47	37	32	17	26	67	26	252
	Pakistan	31	22	17	10	18	63	22	183
	India	14	15	15	7	7	3	4	65
	Afghanistan	2	0	0	0	0	0	0	2
	Nepal	0	0	0	0	0	1	0	1
	Bangladesh	0	0	0	0	1	0	0	1
South America		1	5	2	3	2	10	7	30
	Guyana	0	3	2	2	1	6	4	18
	Venezuela	0	0	0	1	1	1	3	6
	Brazil	1	0	0	0	0	2	0	3
	Ecuador	0	1	0	0	0	1	0	2
	Surinam	0	1	0	0	0	0	0	1
Oceania		6	8	8	1	16	21	15	75
	Papua New Guinea	6	7	8	1	14	19	15	70
	Solomon Islands	0	1	0	0	2	2	0	5
Unknown sources		58	12	10	20	13	0	0	113
Total		2,474	4,042	3,021	3,077	3,139	2,672	2,511	20,936

accounting for only 6.1% of the IMCs. Moreover, 5 countries from South America and 2 countries from Oceania reported 30 and 75 cases, respectively.

From 2012 to 2018, China reported 111 malaria death cases (0.5%, 111/20,936) among the IMCs, and most of these cases died of *P. falciparum* infection (n=108, 97.3%), and China also reported 3 unclassified cases. The deaths mainly reported in Sichuan (n=13, 11.7%), Henan (n=12, 10.8%), and Beijing (n=12, 10.8%). The highest number of deaths occurred in 2014 (n=25).

DISCUSSION

For countries that are approaching or have achieved elimination, imported malaria presents a high risk for resurgence or re-establishment (6–7). In 2018, Hunan Province reported 4 introduced cases (*P. vivax*, first generation), which prompted the Center for Disease Control and Prevention (CDC) staff to strengthen the sensitivity of the surveillance system (8). Since 2012, the proportion of IMCs has increased due to the increased numbers of Chinese workers going to and coming back from abroad. According to data reported by the National Bureau of Statistics of China, the number of migrant workers was 606,000 in 2018, which increased by 16.6% compared to that in 2012 (505,563).

The increasing trend of imported *P. falciparum* cases from 2012 to 2018 may be explained by the increasing number of migrant workers who travelled to or returned from Africa. The number of imported *P. vivax* cases increased before 2012 (9) but decreased after 2012. This decreasing trend may have been due to the decline of malaria cases imported from Southeast Asia, especially Myanmar. Several factors have contributed to the reduction of *P. vivax* in Myanmar. First, the number of *P. vivax* cases in Myanmar continues to decline, and the number of *P. vivax* cases decreased from 53,351 in 2007 to 29,944 in 2017 (10–11). Second, Yunnan Province, which neighbors Myanmar, adopted a “three defense line” strategy in the border areas to carry out joint prevention and control with Myanmar to strengthen the surveillance of IMCs (12). Therefore, the number of *P. vivax* cases reported by the Yunnan Province also declined significantly with a 76.8% reduction from 2012 (599 cases) to 2018 (137 cases). Third, the flow of Chinese nationals changed direction, especially for those in the border areas of Yunnan Province (13).

With regard to the increasing number of *P. malariae* and *P. ovale* cases, the increasing number of overseas workers may be one of the factors contributing to this trend as well as the establishment of the provincial reference laboratories. China has established 24 provincial reference laboratories for all the endemic

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provinces, which have achieved case detection and reconfirmation using polymerase chain reaction and microscopy within 3 day after reporting through the PDIRMS (14). The capacity of the CDC staff to focus on microscopy has strengthened through training by the External Competency Assessment of Malaria Microscopists (ECAMM) held by the World Health Organization (WHO) since 2015. Currently, 19 CDC staff members have obtained first-level certification, and an additional 13 CDC staff members have obtained second-level certification (4).

This study indicated that the number of imported *P. vivax* cases decreased, while imported *P. falciparum* cases increased. Therefore, accurate diagnosis and prompt investigation and response need to be strengthened as well as implementation of mobile population-specific measures, especially at the China-Myanmar border to prevent re-establishment caused by imported *P. vivax* cases (15). Moreover, timely and appropriate treatment by medical staff should be improved to avoid fatal malaria cases caused by imported *P. falciparum*.

This study is subject to at least a few limitations. First, not all IMCs had exact epidemiological information in 2012–2018. Second, there were 113 unknown cases imported from abroad. Third, not all IMCs were confirmed by laboratory methods as 174 clinically-diagnosed cases were included in this study. Finally, an accurate number of *P. ovale* and *P. malariae* cases was not obtained in 2012.

Acknowledgement: We would like to thank the staff members of the provincial and county Centres for Disease Control and Prevention in China for assistance.

Funding: This study was supported by the key techniques in collaborative prevention and control of major infectious diseases in the Belt and Road (2018ZX10101002-004).

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Submitted: November 20, 2019; Accepted: April 20, 2020

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