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Malaria in Taiwan

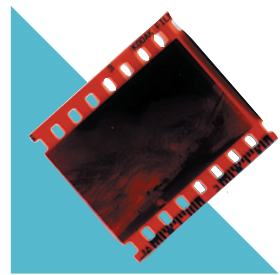
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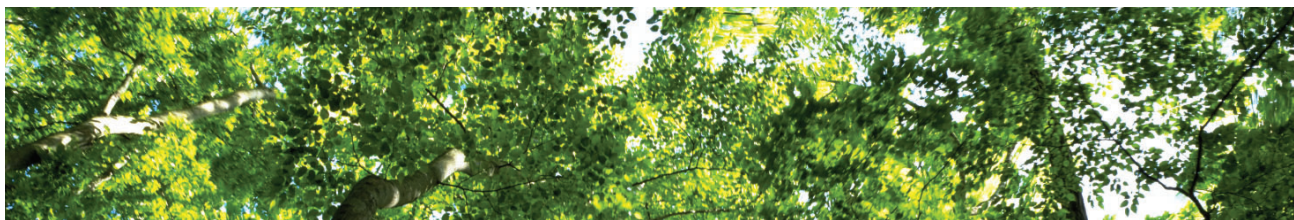
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Epidemiological Analysis of the Maintenance Phase

I. Epidemiology

II. Special-Epidemic Cases





I. Epidemiological Characteristics of Malaria in Taiwan, 1965-2004

Epidemiological characteristics of malaria in Taiwan have changed since the announcement of successful elimination by the World Health Organization (WHO) in 1965. From 1965 to 2004, the total confirmed cases of malaria was 1493, of which 1364 were classified as “imported” and 129 cases were “indigenous” cases (88 were infected in Taiwan, 16 were recurrence of *P. malariae*, one was a recurrence of *P. vivax*, 21 were induction infection, two were caused by intervention and one was vertically infected). In 1975, the highest number of malaria cases was confirmed (87), and 1986 reported the second highest number of cases (68), with an average number of reported cases at 37.33 cases per year (Figure 6). Detailed analysis of these confirmed cases are as follows:

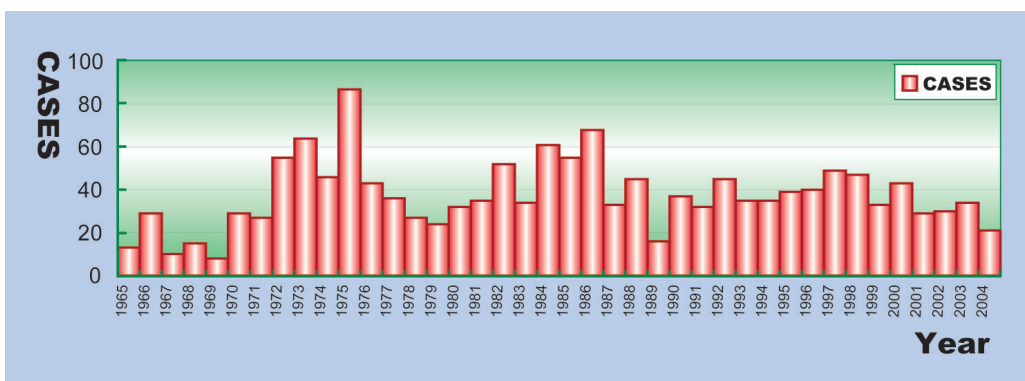


Figure 6: The Distribution of Confirmed Malaria Cases in Taiwan from 1965 to 2004

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(I) Malaria Species

Among the confirmed 1493 malaria cases, 913 were infected with *P. vivax*, 476 were infected with *P. falciparum*, 62 were infected with *P. malariae*, 22 were infected with , and 20 were infected with a mixture of *P. vivax* and *P. falciparum* (Table 5). *P. vivax* became the major species after elimination of malaria and concurrent infections of both *P. vivax* and *P. falciparum* also became higher than past years.

Table 5. Confirmed Malaria Cases infected by different Malaria Species in Taiwan, 1965~2004

Year	<i>P. vivax</i>	<i>P. falciparum</i>	<i>P. malariae</i>	<i>P. ovale</i>	mixture of <i>P. vivax</i> and <i>P. falciparum</i>	Total
1965	2	6	5			13
1966	23	4		2		29
1967	5	1	4			10
1968	6	1	5	3		15
1969	4		2	2		8
1970	18	7	2	2		29
1971	17	4	6			27
1972	44	5	6			55
1973	58	1	2	2	1	64
1974	34	12				46
1975	63	19	5			87
1976	31	8	1	3		43
1977	25	10	1			36
1978	15	11		1		27
1979	16	7	1			24
1980	25	3	4			32
1981	26	9				35
1982	32	18	2			52
1983	22	11	1			34
1984	39	20	2			61
1985	27	24	3	1		55
1986	39	27	2			68
1987	15	18				33
1988	26	19				45
1989	8	8				16
1990	17	20				37
1991	18	12	1		1	32
1992	27	16	1		1	45
1993	24	10		1		35
1994	20	15				35
1995	17	20			2	39
1996	24	11	1	1	3	40
1997	21	25		2	1	49
1998	24	23				47
1999	23	8		1	1	33
2000	24	16	2	1		43
2001	12	13	2		2	29
2002	17	10			3	30
2003	14	15			5	34
2004	11	9	1			21
Total	913	476	62	22	20	1,493

(II) Time Interval between Disease Onset and Diagnosis

On average, an interval of 14.16 days separated the time of disease onset and diagnosis. The median was five days, with cases having a time period less than one-week being 56.73% of total cases, those less than two-weeks amounting to 75.89%, less than three-weeks adding up to 83.32%, and more than one month being 12.53%, with the longest reported time being 308 days (figure 7.). A shorter time interval between disease onset and laboratory diagnosis is very helpful in tracing the source of infection for immediate prevention and control.

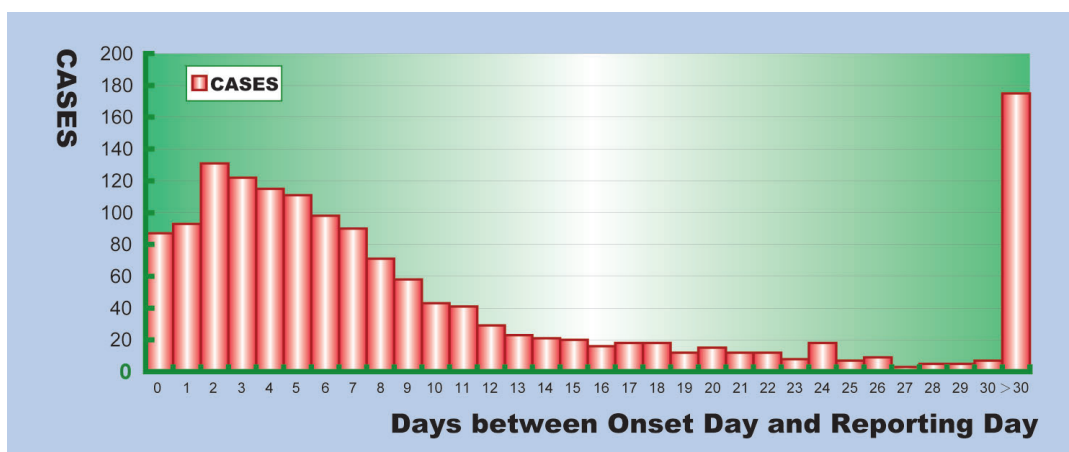


Figure 7: The Time Intervals between Disease Onset and Diagnosis of Confirmed Malaria Cases in Taiwan, 1965-2004

(III) Malaria Cases in Taiwan Originating from other regions of the World

Among the 1,493 confirmed cases, a majority of 1,009 were infected in Asia, 365 in Africa, 98 in Oceania, 10 in the Americas, and one in Europe. There were 10 confirmed cases with unknown origin (Table 6). The fact that most of Taiwan's imported cases came from Asia implies the importance of public education through travel agencies and airlines in minimizing the health threat of malaria.

Malaria Species						
Region	<i>P. vivax</i>	<i>P. falciparum</i>	<i>P. malariae</i>	<i>P. ovale</i>	mixture of <i>P. vivax</i> and <i>P. falciparum</i>	Total
Asia	766	179	49	3	12	1,009
Africa	65	267	11	19	3	365
Oceania	69	23	1		5	98
Americas	8	2				10
Europe	1					1
Unknown Region	4	5	1			10
Total	913	476	62	22	20	1,493

Table 6: Global Distribution of Malaria Cases in Four Different Species

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(IV) Geographical Distribution in Taiwan

Among the confirmed 1,493 cases, besides Kinmen county, all other counties in Taiwan had reported infected malaria cases, including: Keelung City – 43, Taipei City – 370, Taipei County – 279, Taoyuan County – 132, Hsin-chu City – 17, Hsin-chu County – 30, Miaoli County – 15, Taichung County – 29, Taichung City – 38, Changhua County – 34, Nantou County – 36, Yunlin County – 11, Chiayi County – 7, Chiayi City – 13, Tainan City – 47, Tainan County – 29, Kaohsiung City -128, Kaohsiung County – 46, Pingtung County – 48, Ilan County – 31, Hualien County – 54, Taidong County – 37, Penghu County – 37 and Lianjiang County with 2 (Figure 8). The metropolitan area of Taipei City and Taipei County accounted for most of the malaria cases after elimination. Again, this supported the evidence that most of Taiwan's malaria cases were imported so that metropolitan areas with the largest populations had the highest numbers of malaria.

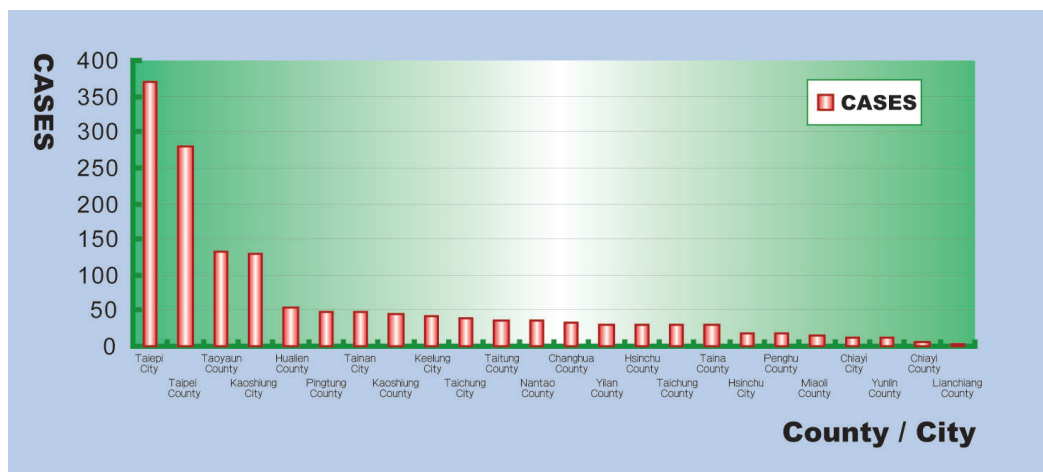


Figure 8: The Distribution of Confirmed Malaria Cases in Taiwan by County, 1965-2004



(V) Age

Most of the confirmed malaria cases were adults, age range 20-60 years old. The distribution of cases in each age group were as follows: there were 27 cases between the ages of 0-4 years old (1.81%), 33 between the ages of 5-9 (2.21%), 42 between the ages of 10-14 (2.81%), 95 between the ages of 15-19 (6.36%), 248 between the ages of 20-24 (10.92%), 248 between the ages of 25-29 (16.61%), 231 between the ages of 30-34 (15.47%), 168 between the ages of 35-39 (11.25%), 160 between the ages of 40-44 (10.72%), 110 between the ages of 45-49 (7.37%), 88 between the ages of 50-54 (5.89%), 57 between the ages of 55-59 (3.82%), 43 between the ages 60-64 (2.88%), 11 between the ages of 65-69 (0.47%) and 17 that were above 70 years of age (1.14%) (Figure 9). The age groups with the most cases were middle-age adults, around 25-34 years old, implying the high exposure to malaria in this age group to import malaria into Taiwan.

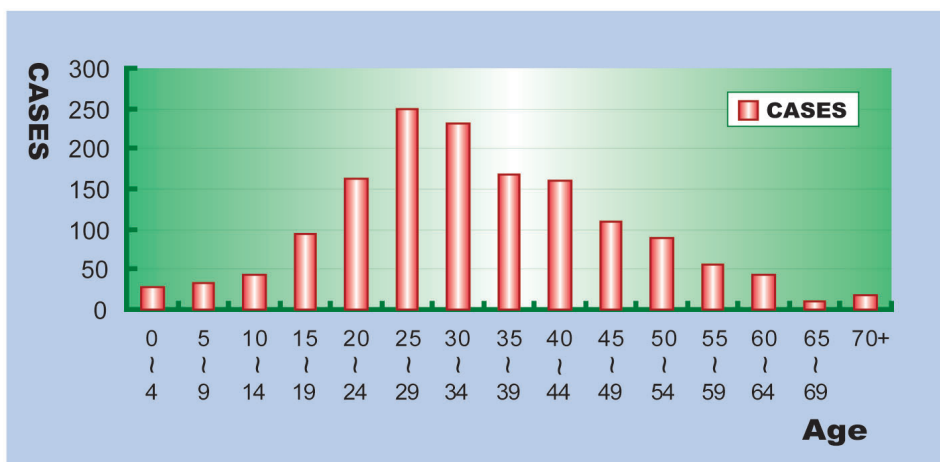


Figure 9: The Distribution of Confirmed Malaria Cases in Taiwan by Age, 1965-2004

(VI) Gender

Among the confirmed 1493 cases, there were 1212 males (81.8%) and 281 female (18.62%), as shown in Figure 10. Males engaged in more outdoor activities that were close to malaria vector habitat, were more likely to acquire malaria infection.

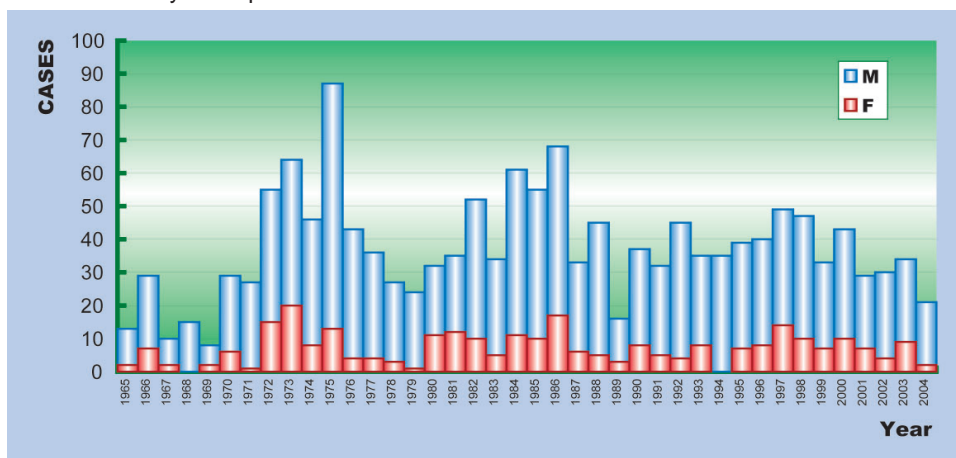


Figure 10: The Distribution of Confirmed Malaria Cases in Taiwan by Gender, 1965-2004

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(VII) Risk factors

Among the 1,493 confirmed cases, there were many risk factors, with foreign employment being the highest with 427 cases (28.6%), 144 due to business related activities (9.65%), 92 due to visiting relatives (6.16%), 88 were infected in Taiwan (5.89%), 78 due to traveling abroad (5.22%), 76 due to immigration (5.09%), 74 were students coming to study in Taiwan (4.96%), 73 expatriates returning to Taiwan (4.89%), 58 were part of a national delegation of agricultural experts that visited foreign countries (3.88%), 48 were foreigners coming to Taiwan for work (3.22%), 44 were foreigners training in Taiwan (2.95%), 30 foreign fishermen (2.01%) and 135 with unknown risk factors (9.04%) (Table 7). Travel and working in malaria endemic countries and bring the highest risk to acquiring malaria. Future efforts are needed to increase malaria education through more systematic channels, such as through foreign visa application, travel activities and occupational health agencies for those companies which have foreign employment in malaria affected countries or areas.

Table 7: Reasons of Infection among Confirmed Malaria Cases in Taiwan, 1965-2004

Risk Groups by Reasons to be Infected	Cases	Percentage
Foreign employment	427	28.60
Business related activities	144	9.65
Visiting relatives	92	6.16
Infected in Taiwan	88	5.89
Traveling abroad	78	5.22
Immigrated to Taiwan	76	5.09
International students in Taiwan	74	4.96
Expatriates returning to Taiwan	73	4.89
Part of a national delegation of agricultural experts that visited foreign countries	58	3.88
Foreigners coming to Taiwan for work	48	3.22
Foreigners training in Taiwan	44	2.95
Foreign fishermen	30	2.01
Induced infection	23	1.54
Refugees from Vietnam	20	1.34
Recurrence of P. malaria	18	1.21
Study and Observation tours abroad	16	1.07
Religious activities	16	1.07
Diplomats	7	0.47
Foreign Brides	7	0.47
Refugees from Indonesia	3	0.20
Transplantation	3	0.20
Medical Mission	3	0.20
Recurrence of P. vivax	2	0.13
Intervention	2	0.13
Recurrence of P. ovale	1	0.07
Foreigners on study tours in Taiwan	1	0.07
Stowaway	1	0.07
Study Abroad	1	0.07
Vertical transmission	1	0.07
Academic Research	1	0.07
Unknown	135	9.04
Total	1,493	100.00

II. Special outbreaks

(I) Reoccurrence or Imported Infection:

From July 1966 to August 1973, there was an outbreak caused by of *P. vivax* in northern Taiwan, with 86 cases, distributed in four counties and two cities, including: Taipei county, Ilan county, Taoyuan county, Hsinchu county, Taipei city and Keelung city, and it was believed that the origin of the infection was a reoccurrence or transmitted by an imported infected case. (Malaria Elimination in Taiwan, May 1991, Department of Health, The Executive Yuan, Republic of China, p. 114). This outbreak was controlled by the proper health authorities, and no new cases occurred thereafter.

(II) Induced infection:

1. Transfusion:

during 1965 to 2004, there were 17 reported cases, of which 16 were *P. malariae*, and one was *P. vivax*. All were infected in Taiwan, but there were no fatal cases.

2. Transplantation:

During 1965 to 2004, there were a total of three cases, of which two were *P. vivax*, and one was *P. ovale*. These three cases were all Taiwan residents that went to Bombay, India, to receive a kidney transplantation, and again, there were no fatal cases.

3. CT scan:

In October 1995, there was a Taiwan resident who was infected with *P. falciparum* in Nigeria, who received care at Taipei Veteran's Hospital. Subsequently, six cases occurred after this initial patient, where the *P. falciparum* could have been transmitted via the medical instruments or human errors in operating the medical instruments. It is believed that this index case from Nigeria was the cause of infection for the other five, of which four were fatal.

(III) Vertical transmission:

On March 30, 1997, a newborn female was diagnosed with *P. falciparum*. After thorough investigation, it was found that the mother was originally from Indonesia, who returned to Indonesia when she was four-months pregnant and was infected there and developed fever, but it was not severe.

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(IV) Reoccurrence:

In June 2002, at Dahsu Shiang in Pingtung County, there was one carpenter returning from Solomon Islands who was infected with a mixture of *P. falciparum* and *P. viva*. The epidemiological investigation found that this person had multiple reoccurrences of *P. falciparum* in August and November of 2002 and in July 2003, and was diagnosed to have *P. falciparum* and Cryptozoites in the liver, which was treated with Primaquine. The treatment was extended from two to three weeks, and the dosage of medication was doubled for a two-week duration. This treatment proved effective in controlling the infection and the patient did not experience further relapse.

(V) Imported cases (secondary)

On September 2003, there was one person from Taidong County, Taimali district, Jinlun village, who was infected with *P. vivax*, and in November of the same year, a military personnel in Kaohsiung city (who also lived in the same area as the previous person) was infected with a mixture of *P. falciparum* and *P. viva*. Detail investigation found that in June 2003, both persons returned from Solomon Island and were infected there before returning to Taiwan. After these reported cases, prevention efforts were carried out to prevent further imported cases, and no any further imported cases were reported.

