SPECIAL REPORT*

EPIDEMIOLOGY AND CONTROL OF MALARIA IN MALAYSIA

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Abstract. In spite of more than 30 years of control activities, malaria continues to be the most important parasitic infection in Malaysia, accounting for 39,189 confirmed cases in 1991, giving an annual parasite incidence rate of 2.2 per 1,000 population. Some factors contributing to the continued transmission of malaria are the development of drug resistant *Plasmodium falciparum,* changes in vector behavior, and ecological changes due to socio-economic reasons. Malaria parasite rates are higher among the Aborigines, land scheme settlers and those in intimate contact with the jungle, like loggers. There has been no substantial change in the proportion of the three common malaria species responsible for infections, *P. falciparum, P. vivax, P. malariae* and mixed infections accounting for about 70%, 28%, 1% and 1%, respectively of all infections. Drug resistant *P. falciparum* is unevenly distributed in Malaysia, but based on clinical experience and *in vitro* drug sensitivity studies, chloroquine resistance is frequently encountered. There has been clinical and laboratory evidence of resistance to sulfadoxine/pyrimethamine combination as well as quinine, but all these have so far been successfully treated with a combination of quinine and tetracycline. The eradication of the disease is impossible in the near future but there is confidence that with better surveillance techniques and the use of alternative control measures like permethrin impregnated bed-nets to complement existing ones, the target of bringing down the annual parasite incidence to 2 per 1,000 population during the Sixth Malaysian Plan period (1991-1995) can be achieved.

INTRODUCTION

The Malaria Control (Eradication) Program has been in existence for more than 30 years, but malaria continues to contribute to significant morbidity and some mortality in the country. From 1980 to 1991, parasitologically confirmed malaria cases ranged from a low of 22,218 in 1983 to a high of 65,283 in 1989. Malaria deaths in the same period ranged from 106 in 1985 to 43 in 1990. The annual parasite incidence (API) was between 1.5 - 4.3 per 1,000 population. Malaria deaths ranged between 0.9 and 2.7 per 1,000 confirmed cases (Table 1). This unsatisfactory situation could be attributed to a number of factors of which drug resistant *P. falciparum,* vector behavior changes, ecological and socioeconomic changes contributed. Intense longitudinal studies have therefore been conducted during the last couple of years to define the epidemiological conditions contributing to this situation, and also to develop more appropriate monitoring and control measures.

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THE MALARIA CONTROL PROGRAM IN MALAYSIA

The Malaria Eradication Program (MEP) was first started in 1961 in Sabah and Sarawak and in 1967 in Peninsular Malaysia, but because of administrative, operational and technical problems encountered, this was changed to a Malaria Control Program in Sabah, Sarawak and Peninsular Malaysia in 1971, 1972 and 1981, respectively (Ho, 1985). Pior to this, it was estimated in 1952 and 1956 that there were 40,000 and 250,000 malaria cases per year in Sarawak and Sabah, respectively. A Pre-Eradication Survey was carried out in 1965-66 with the assistance of WHO to assess the malaria situation, and 168, 409 malaria cases were reported from static and mobile clinics in the Peninsula in the Peninsula (Mohamed, 1965). By 1967 the Malaria Eradication Program was established in Peninsular Malaysia in line with WHO aims (WHO, 1955). In 1978 the Reoriented Strategy of WHO was introduced which was centered on the control rather than eradication of malaria.

In 1986 the vector control programs in Sabah

Table 1

Malaria cases, annual parasite incidence (API) per 1,000 population and malaria deaths in Malaysia by year, 1980-1991.

Year	No. cases (API)				Deaths	
	Pen Malaysia	Sarawak	Sabah	Combined	No.	per 1,000 cases
1980	9110 (0.8)	765 (0.6)	34351 (35.3)	44226 (3.3)	53	1.2
1981	8631 (0.7)	754 (0.5)	50037 (49.5)	59422 (4.3)	51	0.9
1982	12411 (1.1)	956 (0.7)	30548 (29.1)	43915 (3.1)	75	1.7
1983	10069 (0.8)	859 (0.6)	11290 (10.4)	22218 (1.5)	59	2.7
1984	9724 (0.7)	1015 (0.7)	21358 (18.7)	32095 (2.1)	54	1.7
1985	10369 (0.8)	1019 (0.7)	38138 (32.7)	49526 (3.2)	106	2.1
1986	11685 (0.9)	987 (0.7)	31473 (24.9)	44145 (2.8)	67	1.5
1987	10010 (0.7)	1132 (0.7)	25515 (19.4)	36657 (2.2)	75	2.1
1988	12432 (0.9)	1017 (0.6)	37272 (27.2)	50721 (3.0)	72	1.4
1989	16902 (1.2)	836 (0.5)	47545 (33.3)	65283 (3.8)	62	1.0
1990	14066 (1.0)	1244 (0.8)	35190 (24.1)	50500 (2.9)	43	0.9
1991	9879 (0.7)	2132 (1.3)	27178 (15.6)	39189 (2.2)	47	1.2

Source : Vector Borne Diseases Control Program, Ministry of Health, Malaysia.

and Sarawak were standardized with the Vector-Borne Diseases Control Program (VBDCP) of Peninsular Malaysia under the 5th Malaysia Plan (1985-90). The VBDCP objectives are to reduce the morbidity and mortality due to malaria so that it is no more a problem in this country as well as to prevent the spread of the disease to non-endemic areas. Under the 6th Malaysia Plan (1991-95), the aim is to bring down the incidence rate to less than 2 per 1,000 population and the death rate to less than 0.05%.

Like most other present-day malaria control programs the MCP's approach to achieve these objectives is to reduce rapidly malaria prevalence and transmission through the application of residual insecticides for vector control and through chemotherapy of cases. Mass drug administration targeted at every person within an identified group may also be carried out in conjunction with insecticide spraying. The target areas are usually small foci in malaria prone areas, those areas after 2 years of residual spraying, a malaria prone area where there is a outbreak as an additional control measure in conjunction with spraying, interior Orang Asli settlements and new land development schemes.

Case detection and investigation

Active case detection is carried out in problem areas where presumptive treatment is given to those with fever, history of fever and visitors from malarious areas. Radical and follow-up treatment is given for positive cases. The monthly coverage target is 600-2,000 houses covering a population of 3,000 to 10,000. Passive case detection is carried out in patients seeking medical and health services. A target of 10% of these patients is screened for malaria parasites.

Mass blood surveys are carried out in areas with increase in cases, influx of foreign workers, in interior Orang Asli settlements and where there are cases in non-endemic areas. The target is 100% of the houses and not less than 95% of the population concerned.

All reported cases are investigated to determine the source of infection to facilitate prevention and control by staff concerned. All reported cases are followed-up monthly; for *P. falciparum* and *P. malariae* infections, the follow-up will be for 6 months from the date of confirmed infection; for *P. vivax* and mixed infections the follow-up will be for 12 months.

Treatment

For the radical treatment of *P. vivax* infection, standard doses of chloroquine and primaquine are given for 3 and 14 days respectively. For *P. falciparum* infection, a single dose of sulfadoxine/pyrimethamine (SF), and 3 days of chloroquine and primaquine are given.

For presumptive treatment, darachlor (chloroquine/pyrimethamine) is given to suspected cases, before blood examination. For complete radical treatment, SF and primaquine are given to Orang Asli from the deep jungle, armed forces personnel after operations in the jungle and all inhabitants of an outbreak area.

Vector control

Control of vectors through residual insecticide spraying is carried out using DDT 25% (emulsified concentrate) and DDT 75% (water dispersible particles). In endemic areas, regular spraying of houses is carried out once 6 monthly or 3 monthly where needed, in land schemes, logging camps and interior Orang Asli settlements. In addition, focal spraying of houses is carried out in malaria prone and malaria free areas where isolated cases are reported.

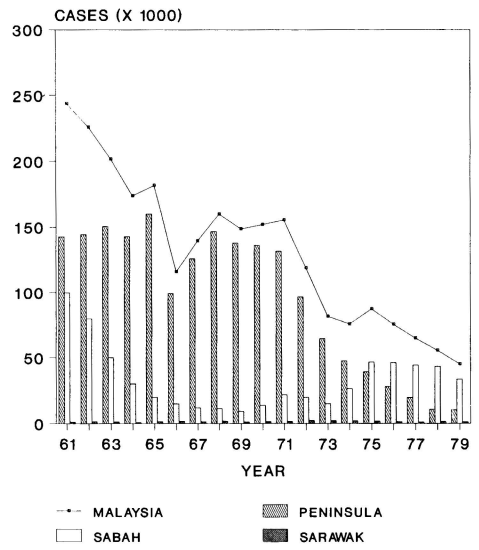


Fig 1—Malaria cases in Malaysia by locality and year, 1961-1979.

In malarious areas Abate 500 E is applied in drains and canals for larval control. Also automatic siphons, tidal gates and sluice gates are constructed to manage water movement in order to control vector breeding.

Intensive entomological surveillance activities are carried out to study vector habits in order to determine the effectiveness of vector control. The biting habits and resting places of the vectors are also studied to monitor their susceptiblity to DDT.

Health education

Health education to create awareness, and appropriate activities such as lectures, group discussions and exhibitions on prevention and control of vector borne diseases are organised for the community. Production of magazines, posters, flip charts and videos on relevant topics are distributed to all states to help local health workers in their health education activities.

Primary health care

In order to encourage participation of the public in the Government's health service, especially in the rural areas, public health care posts are set up in malarious areas with the involvement of local volunteer workers.

EPIDEMIOLOGY OF MALARIA

Before 1960, there was no proper record of the number of malaria cases detected in the country. The number of cases was estimated to be about 300,000 annually before the implementation of the eradication program. The MEP reduced the number of cases from more than 150,000 at the start of the program to less than 50,000 a year in late 1970s (Fig 1). Although the MEP was scheduled to end in 1982, it was found that the objective of MEP could not be attained by then. In 1980, in line with WHO's re-orientated strategy, the Ministry of Health, Malaysia made two major policy decisions at the national level, these being:

(a) To change the concept of complete malaria eradication by 1982 to that of a malaria control program (MCP) with the ultimate aim of malaria eradication.

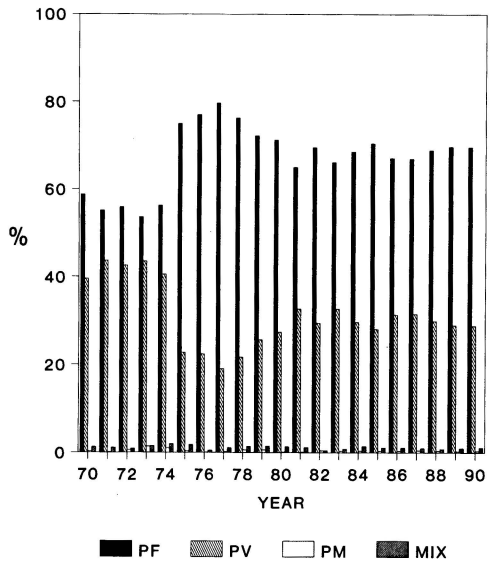
(b) To restructure the MCP 'in phases' from 1981

to 1985 to that of a Vector-Borne Diseases Control Program (VBDCP) covering all other vector-borne diseases.

After 1980, the total number of malaria cases reported was rather constant at below 50,000 cases a year. The largest number of cases was from Sabah. For example, in 1991, there were 39,189 cases of which 25.2% were from Peninsular Malaysia, 69.4% were from Sabah and 5.4% were from Sarawak (Anonymous, 1990). It is interesting to note that while malaria cases reported from the East Malaysian state of Sarawak and Peninsular Malaysia have dropped remarkably during the MCP, those in Sabah have remained high. The annual parasite incidence (API) rates for Peninsular Malaysia and Sarawak have remained constant at around 1 per 1,000 population but in Sabah they fluctuated between 10-40 per 1,000 population from 1980 onwards.

In Peninsular Malaysia, the states with the highest number of cases since 1985 were Pahang, Kelantan, Trengganu, Perak and Johore (Anonymous, 1985). About half of the total cases were reported among special groups such as the security forces, Orang Asli and land scheme workers. The Orang Asli community in Peninsular Malaysia will remain a high risk group as long as malaria is not controlled or eradicated amongst them. With improved transportation, and a policy to integrate them with the other communities, there is increased risk of malaria being transmitted to others. Malaria control among them is a problem as their semi-nomadic lifestyle makes proper treatment and follow-up very difficult.

The jungle in a number of areas in the country is being cleared for agriculture and in recent years the local shortage of labor in these places has resulted in an influx of migrant workers from neighbouring countries. This influx, together with the creation of a habitat conducive to the breeding of malaria vectors, has led to the reintroduction of malaria in certain non-malarious areas of the country. For example, in 1985 the malaria situation in Johore worsened compared to the previous year and this was attributed to the influx of the large number of migrant workers into land development schemes, particularly in the districts of Kluang, Mersing, Kota Tinggi and Johore Bahru (Anonymous, 1985). Other than land schemes, migrant workers in rubber and oil palm estates also contribute to new foci of malaria in the country.



SOURCE: VBDCP, MINISTRY OF HEALTH

Fig 2—Malaria infections in Malaysia by species, percentage and year, 1980-1990. PF, PV, PM and MIX (*Plasmodium falciparum, P. vivax, P. malariae* and mixed infections, respectively).

Figure 2 shows the distribution of malaria parasites by species. *P. falciparum* was the dominant species, followed by *P. vivax* and ocassionally *P. malariae,* which was mainly seen among the aborigines.

With the introduction of DDT residual spraying in 1967 during the MEP, the endophilic and endophagic vectors of malaria, *Anopheles sundaicus* and *An. campestris* were greatly reduced, bringing about the dramatic drop in the number of reported cases in Peninsular Malaysia and to some extent in Sabah and Sarawak. However, the efficient vectors, *An. maculatus* in Peninsular Malaysia, *An. leucospyrus* in Sarawak, and *An. balabacensis* in Sabah are more exophilic and exophagic in behavior and are thus difficult to control. In Sabah, problems of accessibility due to the difficult terrain have affected the institution of control measures, surveillance and supervision, thus partially explaining the high transmission of malaria there.

SEROEPIDEMIOLOGICAL STUDIES IN MALARIA

A number of workers have used various serological tests to measure the endemicity of malaria

in different areas in the country. Thomas *et al* (1980), used the indirect fluorescent antibody (IFA) technique to study the *P. falciparum* antibody profile of adults living in various localities in four states in Peninsular Malaysia, namely Perak, Kedah, Kelantan and Selangor. They showed that antibodies to *P. falciparum* were prevalent in subjects in all areas surveyed, although they varied from low in Kedah and Selangor to a high level in Kelantan, probably indicating a more intense malaria transmission in the latter area.

Longitudinal studies on malaria antibodies using the indirect hemagglutination test (IHA) (Mathews and Dondero, 1982a; 1982b) demonstrated that IHA titers increased with age and the number of malaria attacks in a malaria endemic area and reflected malaria transmission. Other workers have shown that results from both the IFA test and ELISA follow closely that of malaria endemicity in a number of localities in the country such as Lubok Antu in Sarawak, Ulu Jelai in Cameron Highlands and Betau in Pahang (Mak, 1988).

The IFA test and ELISA with schizont antigens prepared from *P. falciparum* and *P. cynomolgi* parasites were used to measure the immune experiences of an Orang Asli and an adjacent Malay village to malaria (Mak *et al,* 1987). It was postulated that the Orang Asli were the source of infection for the Malay village and this was reflected in both the parasitological and serological findings. While the parasite rates declined with age in the Orang Asli as would be consistent with the acquisition of immunity with age in an endemic situation, this rose progressively with age in the Malay population, reflecting infection of the older aged individuals through contact with the Orang Asli. IFA titers were very much higher in the Orang Asli than in the Malays and increased progressively with age, in inverse relationship with parasite rates. ELISA values were also very much higher in the Orang Asli when compared to that of Malays, again reflecting the higher immune experience of the younger age groups in the Orang Asli when compared to that in Malays.

CHEMOTHERAPY AND DRUG RESISTANCE

In view of the increasing problem of drug resistant *P. falciparum* infections in the region, we have introduced monitoring of the *in vitro* response of the parasite to common anti-malarials in addition to assessing the efficacy of hitherto unused drugs for chemoprophylaxis and treatment in Malaysia.

Maloprim (dapsone 110 mg + pyrimethamine 12.5 mg) in those $\geq$ 10 years and half the dose in those 5-9 years was found to be more effective than chloroquine 10 mg/kg weekly as prophylaxis against *P. falciparum,* although breakthrough parasitemia with *P. vivax* occurred (Ponnampalam *et al,* 1976).

Doxycycline was found to be effective in clearing parasitemia in 23 out of 26 (88.5%) patients with *P. falciparum* infection when given at 4 mg/kg daily × 7 days. It was not as effective in the treatment of *P. vivax* infection, and did not cause untoward effects in patients with G6PD deficiency (Ponnampalam, 1981).

In vitro drug sensitivity of *Plasmodium falciparum* isolates

In an effort to obtain base-line data on drug sensitivity patterns for use in the planning of control program, Ho *et al* (1987) carried out studies in various parts of Peninsular Malaysia. Of the 103 isolates successfully cultured, 98% showed schizont growth at $\geq$ 5.7 pmol of chloroquine. All were sensitive to mefloquine. Further tests on isolates collected from various areas in Peninsular Malaysia, showed declining *in vitro* resistance rates, these being 92.8%, 92.8%, 85.0% and 77.0% against chloroquine in 1988, 1989, 1990 and 1991 respectively. *In vitro* resistance against quinine (schizont growth at $\geq$ 256 pmol) and mefloquine (schizont growth at $>$ 64 pmol) showed rates at 16.7% and 4.3% respectively, in 1991.

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