SUSTAINABILITY OF A SUCCESSFUL MALARIA SURVEILLANCE AND TREATMENT PROGRAM IN A RUNGGUS COMMUNITY IN SABAH, EAST MALAYSIA

Jeffrey LK Hii[1,2], KC Chee[1], YS Vun[1], J Awang[1], KH Chin[1] and SKP Kan[3]

[1]Vector-Borne Diseases Control Program, Department of Medical Services, Kudat and Kota Kinabalu, Sabah, Malaysia; [2]Department of Public Health and Tropical Medicine, James Cook University, Townsville, QLD 4811, Australia; [3]Central Medical Laboratory, Queen Elizabeth Hospital, 888586 Kota Kinabalu, Sabah, Malaysia

Abstract. The district of Kudat has one of the highest and most persistent malaria transmission levels in Sabah, Malaysia, with annual parasite incidence of 102 per 1,000 inhabitants per year. Due to this situation and the failure of DDT spraying to control malaria, a community participation health program (*Sukarelawan Penjagaan Kesihatan Primer* or *SPKP*) was developed as an adjunct to current anti-malarial measures during 1987-1991. *SPKP* is made up of unpaid community workers known as village health volunteers (VHVs). VHVs are selected by a village development and security committes training and supervision a member of the Vector-Borne Diseases Control Program (VBDCP). The beneficiaries of *SPKP* consisted primarily of Runggus people and other remote, and mobile populations who visit the home of a VHV for diagnosis and treatment. This group of febrile patients and their children who attend a participating school submit finger prick blood and personal details to the VHV, and receive a presumptive reatment for malaria. Thick and thin blood smears are examined by a VBDCP microscopist who then prepare and forward a radical or curative treatment to the VHV so that it can be administered to the microscopically-positive patient free of charge.

Between June 1987 to June 1991, VHVs from 32 *kampungs* (villages) and 22 schools collected 56,245 slides representing 24.7% of total slide collection compared to 74.9% collected by passive case detection (PCD) posts in health centers and district hospital. The average volunteer treated 11.8 (range 10.4-13.4) and 31.4 (range 26-49) patients per month in *kampungs* and schools respectively. In contrast, non-*SPKP* posts in a district hospital, health centers and flying doctor service treated an average of 616.3 patients per month (range 134.8-1032.8). The slide positivity rate of blood smears taken by VHVs was 8.43% compared with 7.37% for non-*SPKP* posts.

Average slide collection and slide positivity rates varied considerably from one community to another, despite their close geographic proximity. The monthly number of VHV-diagnosed patients from the school and *kampungs* communities and the monthly number of true malaria patients in the two groups were significantly correlated. Sustainability of *SPKP* was linked to an ongoing process of social change which involved co-operative networking between the government health sector and the community. This in turn provided a stimulus for malaria abatement efforts. When Runggus people themselves control and maintain ownership of community-based malaria programs, the function of *SPKP* as a malaria surveillance system and an antimalarial drug distribution network is vastly improved.

INTRODUCTION

In the last two decades, the vertically-oriented malaria control program in the Malaysian state of Sabah have faced considerable difficulties. Strategies like the spraying of residual insecticides and antimalarial chemotherapy, however, cannot be applied as easily in the past because of exophilic behavior in the malaria vector (Hii *et al,* 1991) and parasite resistance to chloroquine (Rahman, 1980). Also, poor DDT spraying coverage (Gramiccia and Beales, 1988; Singh, 1985) and budgetary cuts through enforced programs of economic 'structural adjustment' have made malaria control more difficult and less successful. In ethnic minority areas, malaria problems are exacerbated by inadequate

Correspondence: J Hii, Department of Public Health and Tropical Medicine, James Cook University, Townsville, QLD 4811, Australia.

access to health facilities and essential drugs, distance and lack of community responsibility with respect to health care.

Due to the community-wide impact of public participation for malaria control in the mid 1980s, disease control managers in Malaysia have recently recognized the need for community-based rather than individualised responses (Haji Kechik, 1985). In practice, this necessitates shifting the 'carriers of technology' from the health services or centrally run malaria control programs to the population through the key concepts of primary health care (PHC). Such a program must emphasise the continued active role of the community for whom the program is intended and who are the final beneficiaries. In the most narrow sense, participation occurs when communities carry out aspects of a control strategy which disease specialists, planners or administrators have defined. This is the definition which we adopt for our intervention partly because it combines elements of the 'top-down' with 'bottom-up' approaches. Health service delivery projects have rarely adopted such an approach in Malaysia, and very few locally-initiated pilot projects have been evaluated formally.

In 1987, an unusually successful pilot project was initiated by the Runggus people of Kudat district in north-west Sabah of East Malaysia. This Government-funded project was initiated to catalyse the communities, through existing community structures, to develop and operate community-managed malaria control programs. The succes of the Kudat project showed that increased community surveillance and treatment of fever cases using village health volunteers and a co-operative networking between the health sector and community groups could improve control objectives. This paper examines the sustained efforts of a community participation program over a four-year period in Kudat where attempts were made to transfer malaria control technology to the community. We report the epidemiologic and malariologic outcomes up to 1991.

MATERIALS AND METHODS

Study area and study population

The project was conducted in Kudat district which is located 220 km north of the equator and approximately 136 km north-east of the state capital, Kota Kinabalu (Fig 1). The average population density is roughly 30 per km^2. Kudat is about 25 meters above sea level and is characterized by a tropical wet climate (average temperature 27°C, range 22-32°C). Rainfall is the main climatic feature which shows seasonality with two monsoons occurring from December to March and June to August. The mean annual rainfall is 2,274 mm per annum. Considerable annual variations in onset, amount and duration of rainfall occur.

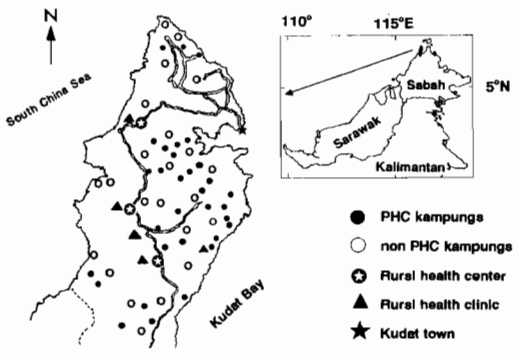

Fig 1– Map of Kudat district showing the study area.

Almost 75% of the population are Runggus who practise slash and burn swidden agriculture with hill padi as the primary crop supplemented by cassava, maize, vegetables and fruits. The most important social groupings in Runggus society are the domestic family, the longhouse and the *kampung*. The longhouse community has a sophisticated social system based on customary law and practices (Appell, 1986). It is a set of nuclear families engaged in individual production and balanced reciprocal exchange of labor. The concentrated nature of communities living in longhouses facilitates residual house spraying and malaria control. However, during rice cultivation and harvesting seasons, farmers and swidden agriculturalists often use temporary and remote on-site farm huts for several weeks. Occupation of these huts during the months of April-May and October-November is generally thought to be a high risk factor for malaria transmission. In 1987, about 65% of the Runggus population lived in areas of active malaria transmission.

Annual parasite incidence (API) for Kudat district fluctuated from 34.5 per 1,000 inhabitants in 1970 to 102.4 per 1,000 in 1988, with a nadir in

1983. Approximately 85.4% of the infections are due to *Plasmodium falciparum* and 14.5% to *P. vivax*. *In vitro* resistance of *P. falciparum* to 4-aminoquinolines and sulfadoxine-pyrimethamine has been reported (Rahman, 1980; Storey and Tambakau, Personal communication). In the 1987 census, the crude mortality rate was 4.6 per 1,000 population (Department of Statistics, 1987). Because of the predominance of *P. falciparum* infections and the limited availability of over-the-counter antimalarial drugs, malaria is responsible for considerable mortality and morbidity; nearly all residents have personal experience with the disease or have observed it in family members or friends. Furthermore, with the low socio-economic situation of many families, a few days lost from work or lower productivity at work as a result of a malarial illness may cause severe hardship.

Spraying sqauds from Kudat routinely visit all houses among 109 *kampungs* one to two times a year and apply *ad hoc* mass drug administration when the API exceeded 10 per 1,000 per *kampung*. At the same time, parasitological diagnosis of fever cases and antimalarial chemotherapy through a network of three health centers and a district hospital (located in Kudat town) has supplemented the program as a means of reducing morbidity. The Vector-Borne Diseases Control Program (VBDCP) defines a case of malaria as a patient with a positive blood smear. Depending on the workload, some attempts have been made to identify patients who have had recurrent parasitemia, with a one month period but in nearly all cases, all episodes of malaria are included in the number of malaria cases reported by the VBDCP.

Selection of health volunteers

In May-June 1987, 13 *kampungs* in the study area with a population of 4,950, were invited to join the community participation program (*Sukarelawan Penjagaan Kesihatan Primer* or *SPKP*) organised and sponsored by the Department of Medical and Health Services. Initially 4 *kampungs* declined to join but 3 have done so subsequently. The point of entry was through the *penghulu* (head of *kampung*) who is usually the chairman of the Village Development and Security Committee. The *penghulu* is selected by the State Government to be in-charge of a few *kampungs* on the basis of his social status and the respect he commands in the community.

On 10 May 1987, details of *SPKP* were outlined and explained to 12 *penghulus* and 12 school teachers, and they were asked to discuss this proposal. It was proposed that each *kampung* should select at least one person to be trained by the VBDCP as a village health volunteer (VHV). A standby volunteer was also necessary in order to share the workload and to serve as a replacement if the colleague became ill or needed to attend to private matters. Guidelines for selection of suitable volunteers, included these preferences: functional literacy in Bahasa Malaysia, the national language, married couples and personal aspiration to participate.

Health officials emphasized that no renumeration would be granted for VHVs. Instead they would receive official recognition and incentives for their services, *eg* certificates of merit, priority for medical consultation at the district hospital and display of logo signboards in their houses. State and district authorities (Departments of Education, Local Government and Community Services) gave much-needed political support and feedback towards these activities. After the May 1987 meeting, VBDCP staff made four visits to the appointed *SPKP kampungs* for interviews with elected volunteers and community elders.

Intervention activities

Training of village health volunteers: A series of on-site training courses (each of 2-day duration) for the first group of 35 trainees was held in May 1987 in their respective *kampungs*. Training courses were a basic hands-on approach to applied malaria technology. A mixture of illustrated talks, demonstrations, discussions and practical sessions covered these topics: the malaria life cycle, causes and symptoms of disease (particularly those causing fever), malaria diagnosis, blood slide taking, presumptive and radical treatment and maintenance of a basic malaria kit. During the training each VHV was guided by a pictorial training manual for malarial fever diagnosis, blood slide taking, presumptive treatment and personal protection measures. The kit included a supply of antimalarial drugs, analgesics, multi-vitamins and ferrous fumerate provided by the Health Department.

The VHV trainees were taught to treat fever attacks using age-calibrated prepacked single-dose tablets (10 mg chloroquine base/kg and 15 mg primaquine base/kg). After receiving confirmed positive blood slide results (usually 2 to 5 days later), they collected or received a radical or cura-

tive treatment to administer to the patient. For *P. falciparum* infections, this treatment consists of a stat dose 21 mg/kg of sulphadoxine-pyrimethamine (Fansidar) plus 15 mg primaquine/kg); *P. vivax* infections were treated for three days with 25 mg/kg chloroquine and for 14 days with 15 mg primaquine/kg. All antimalarial drugs given to the VHV were individual pre-packed envelopes with appropriate daily dosage regimes by age groups. Each VHV was taught to maintain a malaria record book of all patients seen by him or her indicating the name, age, sex, symptoms, treatment, dates seen and treated. An original copy of these details together with the slides were to be sent to the PCD post for diagnosis and filing whilst the carbon-copied records were retained by the VHV.

Supervision and continuing training of VHVs: After receiving training, the first batch of volunteers started work in their *kampungs* and schools. Anyone presenting to these volunteers with fever was blood-filmed and given a single course of presumptive drugs. Patients with symptoms or signs of other diseases were sent with a referral letter to the health center or hospital. Each week or fortnight a malaria supervisor visited the VHV to check the register books, enter the parasitological results for all registered patients, give advice on the VHV's work, and replenish supplies. Through these co-operative networking, continual program evaluation and training were maintained. Each VHV was encouraged to submit slides on a daily basis if public transport was available. In ten *kampungs,* VHVs had arranged with friends or relatives who owned or had access to vehicles to deliver slides and drugs to and from health centers. A medical assistant also saw the VHVs each time he or she conducted a mobile health clinic into "underserved" areas. On such trips he or she was accompanied by one of the community nurses who provided maternal and child care services. Quite separately, a rural health supervisor (sanitarian) made regular visits to these areas to meet *penghulus* for maintenance followups and participatory schemes in environment health projects. Thus, apart from the weekly or bi-weekly visits of the malaria supervisor, nearly all VHVs maintained this networking channels with the health staff. Initially, 12 villagers and 23 teachers joined the *SPKP* program; by June 1989, 72 teachers and 33 villagers had received on-site training and had, at one time or another, actively participated in the *SPKP* intervention program for malaria control.

Malariology

Blood films were stained and diagnosed by malaria microscopists in Kudat malaria office or one of the three health centers. Weekly data on malaria diagnosis, slide collection and parasitological results were compiled and aggregated for each VHV post. The trend of monthly number of diagnosed patients *(x)* and monthly number of true malaria patients *(y)* among the two groups was analyzed; regression models were constructed, based on the equation; $y = a + bx$.

All deaths that were reported to health facilities were investigated by a simple verbal autopsy (VA) technique to determine the cause of death. A health inspector, trained in the VA technique, administered a questionnaire to the parents of each deceased person within 1 to 4 months of death. He conducted a structured interview to determine the sequence of events leading to death, followed by an enquiry into the presence and duration of specific symptoms during the terminal illness. Cause of death was also investigated by compiling health facility records if the deceased had received any medical treatment. Cause of death was assessed by a hospital physician according to a classification of symptoms complexes. Death was attributed to malaria when a history was obtained of an illness of sudden onset, characterized by unarousable coma with positive peripheral blood smear for asexual forms of *P. falciparum* in whom other causes of encephalopathy have been excluded.

RESULTS

Community slide collection

During the project, 48 VHV posts comprising 32 villages and 22 schools, had participated in *SPKP* (Fig 1). All VHVs from these posts collected 22,290 and 33,955 slides from schools and villages respectively. Together this represented 25.1% of all blood slides reported by the VBDCP over a four-year period. The slide positivity rate of blood smears taken by VHVs was 8.43% compared with 7.37% for non-*SPKP* sources (eg PCD posts in health centers, district hospital and flying doctor service). Wilcoxon Rank Sum Test was used to compare total slides collected per month per VHV during June 1987 to June 1991. Significant differences were consistently seen in the yearly average

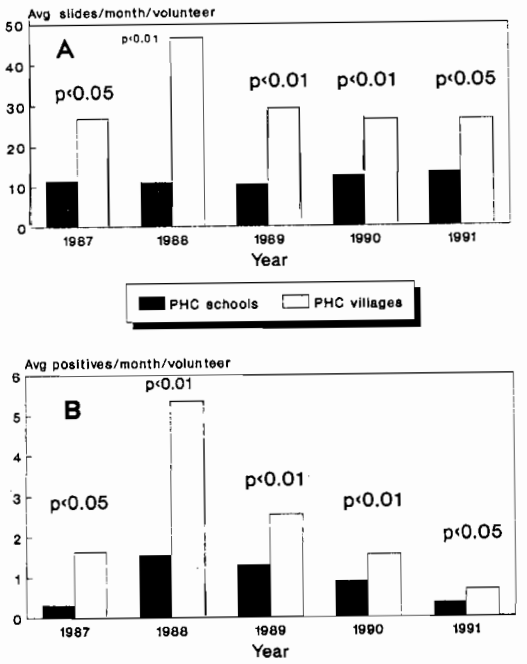

Fig 2– Variation in average slide collection (A) and average slide positivity rates (B) per month per volunteer, 1987-1991, 1987: June-December and 1991: January-June. Observed two-tailed p values were from Wilcoxon matched pairs signed rank test.

number of slides per volunteer (Fig 2A) and average positive slides per volunteer (Fig 2B) between schools and villages. Since slide collection rates are equivalent to presumptive treatment rates, the number of patients treated per teacher ranged from 10.4 to 13.4 per month (mean 11.8 per month) for teachers compared with 26 to 49 per month (mean 31.4 per month) for village-based VHVs. The number of patients treated by non-*SPKP* posts in health centers and hospital ranged from 135 to 1,033 (mean 616.3 per year or 51.4 per month).

A highly significant correlation between the monthly number of VHV-diagnosed patients and the monthly number (note that both numbers are plotted on a logarithmic scale) of true malaria patients in that group was found in *kampung* ($r = 0.97$, $p < 0.001$, using Spearman's rank correlation) and in schools ($r = 0.87$, $p < 0.001$) (Fig 3). The average monthly positive predictive values were 0.091 ± 0.063 (sd), 0.0754 ± 0.041 and 0.081 ± 0.039 in schools, *kampungs* and non-*SPKP* villages respectively. The individual monthly values decreased from PHC schools (range: 0-0.248), non-*SPKP* villages (range: 0.017-0.220) to *SPKP kampungs* (range: 0.011-0.168), the latter showing relatively little variation irrespective of changes in the number of consultations. The number of active VHVs is linearly related to slide collection (data not shown) in *SPKP* schools ($R^2 = 0.83$) and *SPKP kumpungs* ($R^2 = 0.69$) on a logarithmic scale.

Slide positivity rates

Monthly SPRs among schools and villages were positively correlated with each other ($r = 0.82$, one-tailed $p < 10^{-3}$, 47 df) as were SPRs between *SPKP* schools and PCD posts ($r = 0.81$, one-tailed $p < 10^{-3}$, 47 df) and SPRs between *SPKP* villages and PCD posts ($r = 0.80$, one-tailed $p < 10^{-3}$, 46 df) during 1987-1991 (Fig 4A). The number of village-based VHVs inceased dramatically from 3 in July 1987 to 30 in April 1989 and stabilized around the latter throughout (Fig 4B). On the other hand, the number of teachers rose steadily from 12 in June 1987 to 58 in June 1989, but were sharply reduced to 1-6 in the last month of each year during school holidays (Fig 4B).

Overall, slide collection from schools represented 9.9% (range: 7.2-14.2%) of the gross total slides compared to 15.2% (range: 4.4-18.2%) from villages. PCD sources contributed 74.9% (range: 67.6-88.3%) (Fig 4C). Rainfall ranged from 1,270 mm to 2,817 mm in a bimodal pattern (Fig 4D) with the lowest and highest precipitation recorded in 1987 and 1988 respectively. SPRs peaked in late November of 1987 to 1989 during the wet season closely tracking rainfall levels. Rainfall lagged by

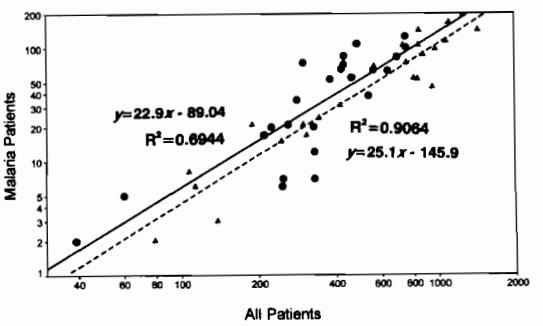

Fig 3– Correlation between monthly number of patients with a clinical diagnosis of malaria and monthly number of those who also had positive blood films (all parasite densities inclusive) in schools (closed circles) and *kampungs* (closed triangles).

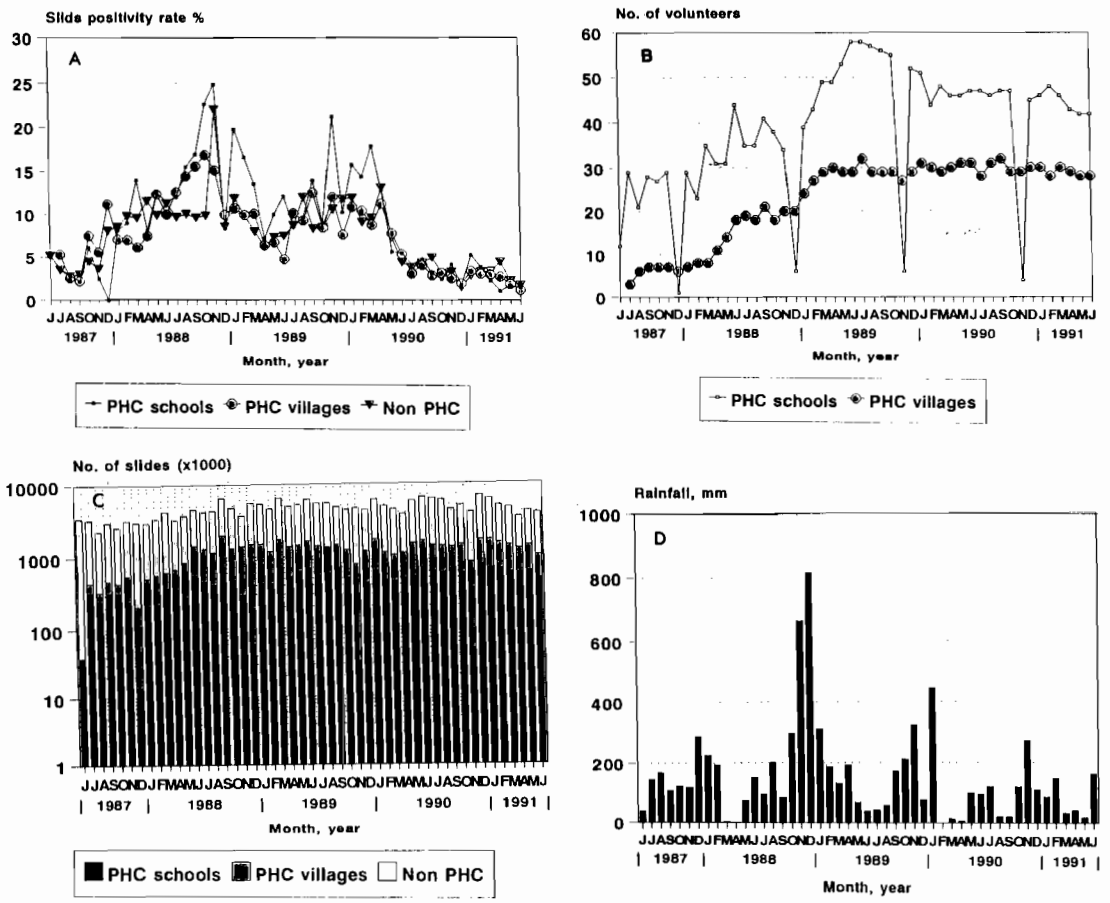

Fig 4– Monthly trends of: (A) gross slide positivity rate, SPR, (B) number of VHVs, (C) slide collections from June 1987 to June 1991, (D) rainfall.

one month was significantly correlated with *SPKP* slide positivity rate (r = 0.32, p = 0.026), but not with *SPKP* slide collection (r = 0.28, p = 0.054), PCD slide collection (r = 0.083, p = 0.57) or PCD slide positivity rate (r = 0.26, p = 0.073).

Annual SPRs showed a gradual decline from 1988 to 1991, but were not significantly different between *SPKP* and non-*SPKP* areas between 1987 and 1991 (Fig 5).

Parasite positivity rates

The annual *P. falciparum* positivity rate was significantly higher in non-*SPKP* areas than in *SPKP* villagers in 1989, but significantly lower in 1988-1990 (Fig 6A). However, annual *P. vivax* positivity rates were significantly higher in non-*SPKP* areas than in *SPKP* villages throughout the study period (Fig 6B).

Malaria mortality

Cases of severe and complicated malaria are usually reported and referred to the nearest health facility or VHVs. When these cases resulted in death either at the health center or district hospital, followup investigations are routinely conducted to determine the causes and validate information received. Relatives of the deceased are then visited to obtain a history of the illness which resulted in death, using a standardized interview form. Although the incidence of severe and complicated malaria in *SPKP* villages was half of that in non-*SPKP* villages (Table 1), the proportion of deaths due to cerebral malaria was not significantly different between the two areas (p = 0.49, Fisher's exact test).

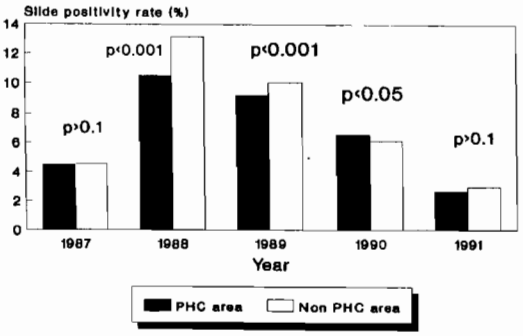

Fig 5– Changes in annual slide positivity rate among *SPKP* (dark bars) and non-*SPKP* (light bars) areas, 1987-1991. 1987: June-December and 1991: January-June. Significance of the difference between the two areas in each year is denoted by p.

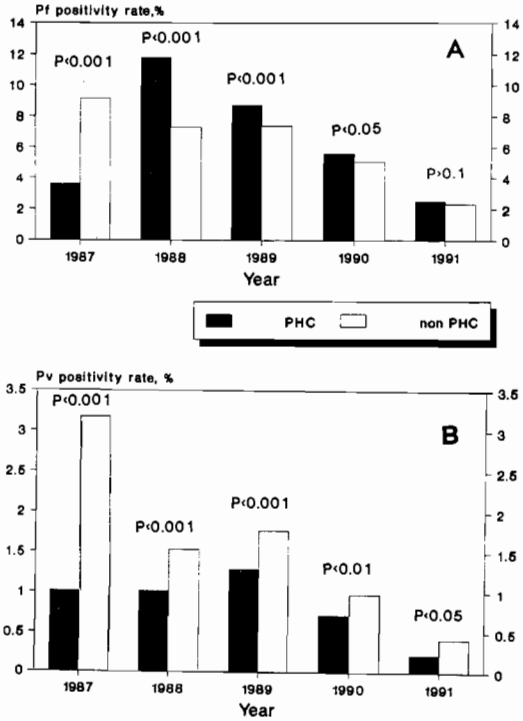

Fig 6– Positivity rates of *P. falciparum* (A) and *P. vivax* (B) in *SPKP* (dark bars) and non-*SPKP* (light bars) areas, Kudat district from Jun 1987 to Jun 1991. Significance of the difference between the two areas in each year is denoted by p.

DISCUSSION

With the exception of the first successful community-based environmental health project in Tambunan district in North Borneo (now Sabah)

Table 1

Incidence of reported cases of severe malaria and deaths due to cerebral malaria in Kudat district, Sabah.

Year	Deaths (No. of severe cases)	
	Non-*SPKP*	*SPKP*
1987	0 (2)	0 (4)
1988	1 (4)	0 (5)
1989	2 (11)	1 (6)
1990	0 (5)	0 (0)
1991	0 (0)	0 (0)
1992	1 (0)	0 (0)
Total	4 (22)	1 (15)
Case fatality rate (%)*	15.4	6.25

*p = 0.46 (Fisher's exact test)

(McArthur, 1954, 1980) and a comprehensive primary health care project in Keningau district (Chen *et al,* 1989), very few case studies have documented the impact of community-based malaria control program on malaria in Malaysia. Our study demonstrates that a high level of community participation was required for continuous functioning and sustainability well over 1991, when VHVs participated in distributing and treating lambdacyhalothrin-impregnated bednets for eleven villages with a population of 2,183 (Hii *et al,* 1995). As *SPKP* evolved, the level of community participation increased and this was primarily attributed to the careful selection, training and supervision of the VHVs, with continuing support provided by the health sector. In many ways, the *SPKP* is similar to the Volunteer Collaborator Network (VCN) of Latin America which is one of the oldest and most successful models for community participation in malaria case detection and treatment (Ruebesh and Goday, 1992). Elements of similarity included the use of unpaid volunteer workers as the principal source of timely, appropriate antimalarial treament for residents of rural areas who have limited access to health care. Whereas the VCN has almost completely replaced active case detection as the principal method of malaria surveillance used by the Guatemalan National Malaria Services (Ruebesh and Godoy, 1992), the same cannot be said of *SPKP* as it contributed 25% of all blood smears collected by the VBDCP. The VCN has had a 30-year old

history of successful implementation compared to the 4-year life of *SPKP*.

One of the major reasons for the success of the *SKPK* is the close, one-on-one supervision in the field by the Kudat VBDCP technician on a regular basis. During the first year of *SPKP* biweekly or monthly supervisory visits were made by senior headquarters staff to provide guidance and material support and to ensure proper networking. As more *SPKP* posts were opened up, the Kudat VBDCP staff had to cope with increasing number of blood slides. Increasing the number of VHVs led to increasing rate of slide collection. This implies that the increasing rate of slide collection has some inherent multiplier effect of increasing program size. As it was the responsibility of two health staff from VBDCP (a technician and a public health overseer) to supervise and visit all VHVs during the expansion of *SPKP*, one can rule out this phenomenon as a historical artifact of improving the overall program efficiency as time passed. Over a period of four years, these two VBDCP staff supervised 79 VHVs amongst 54 villages and schools covering a catchment population of 10,341. In addition, 3 malaria microscopists examined an average of 84 slides per man-day during the first 26 weeks of 1989, compared to 41 slides per man-day before *SPKP* was introduced. The increased slide examination rate far exceeded the routine limit and might have imposed a great strain on the microscopists at the expense of quality and accuracy.

There are two ways to overcome the problem of an expanding *SKPK* network which seeks to detect and treat malaria cases at an increasing rate per year. On the average, school teachers detected and treated one-third the number of patients seen by village-based VHVs. This suggests that school-aged children represent about 33% of the high-risk group of patients or that the VHV post is located in a low transmission zone. When so few patients are seen per month (average range 5-10), the value of any epidemiologic information gathered is questionable. Since volunteer workers spend as much time in the supervision of an unproductive VHV as they do with more active and productive VHVs, Ruebesh *et al* (1994) have prescribed simple and inexpensive modifications such as administering antimalarial drugs without taking blood smears in smaller villages or areas with lower levels of transmission. It may be necessary to limit epidemiologic data collection to representative indicator villages with functioning VHVs in the SPKP area for planning and evaluation purposes . The second solution seems more appropriate because it will, for the first time, allow the volunteer worker to use a simple dipstick technology, the ParaSight^{R} F-test, in order to make a rapid diagnosis of *P. falciparum* malaria without recourse to light microscopy (Shiff *et al,* 1993). Secondly, a test which is carried out while the patient waits would be much more efficient than what is currently practiced in most rural health centers and district hospitals. Thirdly, a more rational diagnosis and treatment strategy could also help conserve the current antimalarial drugs and help delay further development of resistant strains of the parasite. The high specificity (72.1%) and sensitivity (93.8%) of this novel technique in the hands of Tanzanian village health workers (Shiff *et al,* 1994) warrant its deployment at the community level in remote areas where there is no electricity. If proven to be cost-effective, it may require a more stringent set of guidelines for proper use by the VHVs.

Improvements also occurred in the performance of the *SKPK* as a facility for providing timely, appropriate treatment for febrile illnesses attributable to malaria among the relatively remote communities. VHVs treated twice as many patients per month in June 1987-May 1988 than in June 1989-May 1991, even though the incidence of malaria infections and the frequency of febrile illnesses suspected of being malaria decrease markedly. Without data on completion rates of radical treatments, we cannot assess the effectiveness of antimalarial therapy to febrile patients in rural areas. This aspect deserves further studies.

The striking reduction in slide positivity and parasite rates that occurred in the project area from mid-1990 to 1991 (*cf* 1988) defies explanation. Although it would be tempting to attribute these changes to increased *SPKP* activities and chemotherapy, we have no evidence to support this contention, since a similar reduction was observed in non-*SPKP* areas during the same period. As it is unlikely that significant human migration or changes in vector preference have occurred, we postulate that the 1991-1992 El Nino-Southern Oscillation (ENSO)-linked dry periods (Nicholls, 1993) might have cause a depression in malaria incidence. Following the previous 1982-1983 drought in Kudat, the API dropped to 11.3 per 1,000 in 1983 (VBDCP Annual Report, 1983). Significant climate-induced

(*eg* climatic warming and increased rainfall) increases in malaria such as those occurring in Rwanda (Loevinsohn, 1994) may potentially confound the interpretation of epidemiological impact of *SPKP* activity.

We found that the treatment of presumptive clinical malaria by VHVs with chloroquine followed by Fansidar-primaquine combination for microscopically confirmed cases in *SPKP* and non-*SPKP* areas did not have a significant effect on mortality from malaria. This conclusion parallels the results obtained in The Gambia where treatment of presumptive episodes of clinical malaria with chloroquine by village health workers did not have any significant effect on mortality or morbidity from malaria (Greenwood *et al,* 1988). Because we did not implement a village-based reporting system, there is a bias in the amount of deaths reported from the project area. Nevertheless, severe malaria was much more frequent in non-*SPKP* villages compared to *SPKP* villages although the difference was not statistically significant.

As expected, there was a direct relationship between the number of patients seen by the VHV and the number of patients diagnosed as malaria at all density levels. These results suggests that most of the changes in the monthly number of true positive diagnoses were attributed to monthly changes in the incidence of malaria, whereas a considerable proportion of the changes in the number of school children diagnosed by teachers were due to other causes. Since children formed a large proportion of the incidence of lower respiratory tract infections (Selwyn, 1990; Smith *et al,* 1991), acute respiratory infections and other febrile illnesses might possibly confound the accuracy of clinical diagnoses made by school teachers in Kudat. Case-control analysis following Smith *et al* (1994) are necessary to examine the age dependence of the relationship between *P. falciparum* malaria-attributable morbidity and parasite density in Kudat health centers.

In this and a previous survey (Hii and Kan, unpublished report), we found that malaria frequently kills within a short time from the onset of symptoms, sometimes within only 2-3 days, so there may be only a short interval between the time at which a mother first recognises that her child is seriously ill and the time by which treatment must be given if death is to be prevented. Unfortunately, the VHV may not be available during this period when he or she is urgently needed. In Kudat district VHVs were supported only on a voluntary basis by their villages so that to maintain their own families they have to farm or do other work that may take them away from their village. This is borne out by the fact that a 3-year-old male living in a *SPKP* village who was thought to have died from malaria had not been seen by a VHV during his final illnees.

We concur with Ruebesh and Godoy (1992) that the establishment of 'highway pharmacology' at the village level will not by itself control malaria. Even so, the safe administration of a drug by a VHV will not be completely effective against drug-resistant *P. falciparum* which is prevalent in Kudat, and therefore will not have much impact on the overall prevalence of malaria. However, the timely administration of antimalarial therapy will undoubtedly reduce malaria morbidity and perhaps mortality. Furthermore, in many rural areas of Malaysia, where the alternatives are either no treatment or self-medication with all its attendant problems, a network of treatment posts, such as the *SPKP,* offers an appealing answer. The *SPKP* therefore meets the World Health Organization's (WHO, 1986) recommendation that, in places with no properly equipped health care centers, treatment should be administered by primary health care workers on the basis of a clinical diagnosis. The suggestion that self-medication should be accepted and improved by dissemination of knowledge about effective treatment policies and proper dosing (Foster, 1995) stresses the importance of a community-based diagnosis and treatment outside the formal health services. It would be a suitable model for community-based malaria surveillance and treatment programs in other areas where the goals of the national malaria program may be different and/or the health care system infrastructure less well-developed.

ACKNOWLEDGEMENTS

We thank Dr Chong Chee Tsun for his initial criticisms of 'primary health care' concept which provided the stimulus for this project and health officers of the Sabah Vector-Borne Diseases Control Program. In particular, we acknowledge the assistance of the following members of the Health Department. Hj Dr Mohd Shukor, Yong Tet Phin, Edward Pudin, Ahmad Safri and Hj Dr Yusof Yacob for providing administrative support and resources.

Drs KL Palmer, Hassan bin Abdul Rahman, GB White, D Leake and S Bjorge are also thanked for valuable comments. Grateful thanks to R Scott and D Canyon for preparing Figs 1 and 3. We also thank the Director-General of Health Malaysia for permission to publish this article. Finally, our deep gratitude to the people of Kudat who allowed us to record the process of community development they were doing: they have changed our attitudes to health services.

REFERENCES

Appell GN. Social anthropological research among the Runggus Dusun. *Sabah Soc J* 1986; 8 : 194-209.

Chen ST, Chen PCY, Chan MKC, *et al.* Primary health care in Keningau, Sabah, Malaysia. University of Malaya, Kuala Lumpur, Malaysia, 1989 : 67 pp.

Department of Statistics. Vital statistics, Sabah, 1987: 118 pp.

Foster S. Treatmcnt of malaria outside the formal health services. *J Trop Med Hyg* 1995; 98 : 29-34.

Gramiccia G, Beales PF. The recent history of malaria control and eradication. In: Wernsdorfer WH, McGregor I, eds. Malaria - Principles and practice of malariology, London: Churchill and Livingstone, 1988 : 1335-78.

Greenwood BM, Greenwood AM, Bradley AK, *et al.* Comparison of two strategies for control of malaria within a primary health care program in the Gambia. *Lancet* 1988; 1 : 121-7.

Haji Kechik AR. Malaria control program in connection with primary health care in the state of Kelantan, Malaysia. In: Harinasuta C, Reynolds DC, eas, Problems of malaria in the SEAMIC countries, Proceedings of the 12th SEAMIC Workshop, Bangkok,Thailand. SEAMIC Press,Tokyo, Japan, 1985 : 107-114.

Hii J, Chew M, Sang VY, *et al.* Population genetic analysis of host seeking and resting behaviors in the malaria vector, *Anopheles balabacensis* (Dipetra: Culicidae). *J Med Entomol* 1991; 28 : 675-84.

Hii J Alexander N, Chee KC, *et al.* Lambdacyhalothrin-treated bednets control malaria in Sabah, Malaysia. *Southeast Asian J Trop Med Public Health* 1995; 26 : 371-4.

Loevinsohn ME. Climatic warming and increased malaria incidence in Rwanda. *Lancet* 1994; 343: 714-8.

McArthur J. The control of malaria in Boneo. *Trans R Soc Trop Med Hyg* 1954; 48 : 234-41.

McArthur J. The ecological eradication of *Anopheles balabacensis.* Proc Xth Int Congr Trop Med Malaria, Nov 9-15, 1980: 84-5.

Nicholls N. El Nino-Southern Oscillation and vectore-borne diseases, *Lancet* 1993; 2 : 1284-5.

Rahman MKK. Study of *Plasmodium falciparum* resistance to 4-aminoquinolines (chloroquine) in Sabah, Malaysia. *J Trop Med Hyg* 1980; 83 : 259-64.

Ruebesh II TK, Godoy HA. Community participation in malaria surveillance and treatment. I. The volunteer collaborator network of Guatemala. *Am J Trop Med Hyg* 1992; 46 : 248-60.

Ruebesh TK, Zeissig R, Koplan JP, *et al.* Community participation in malaria surveillance and treatment III. An evaluation of modifications in the volunteer collaborator network of Guatemala. *Am J Trop Med Hyg* 1994; 50˜: 85-98.

Selwyn, BJ. The epidemiology of acute respiratory tract infection in young children: comparison of findings from several developing countries. *Rev Infect Dis* 1990; 12 (suppl 18): S870-88.

Shiff CJ, Premji Z, Minjas JN. The rapid manual Para Sight-F test. A new diagnostic tool of *Plasmodium falciparum* infection. *Trans R Soc Trop Med Hyg* 1993; 87 : 646-8.

Shiff CJ, Minjas J, Premji Z. The ParaSight^{R}-F test: A simple rapid manual dipstick test to detect *Plasmodium falciparum* infection. *Parasitol Today* 1994; 10 : 494-5.

Singh J. Malaria Control Program in Malaysia. In: Harinasuta C, Reynolds DC (eds). Problems of malaria in the SEAMIC countries. Proceedings of the 12th SEAMIC Workshop, Bangkok, Thailand. SEAMIC Press, Tokyo, Japan, 1985 : 26-43.

Smith T, Lehmann D, Coakley C, *et al.* Relationships between growth and acute lower respiratory infections among children under five years of age in a highland population of Papua New Guinea. *Am J Clin Nutr* 1991; 53 : 963-70.

Smith T, Genton B, Baea K, *et al.* Relationships between *Plasmodium falciparum* infection and morbidity in a highly endemic area. *Parasitology* 1994; 109 : 539-49.

VBDCP. Vector-Borne Diseases Control Program Annual Report, Sabah, Malaysia. 1983.

WHO. Expert Committee on Malaria. Eighteenth Report. *WHO Tech Rep Ser* 1986: 735.