UNEQUAL TREATMENT ACCESS AND MALARIA RISK IN A COMMUNITY-BASED INTERVENTION PROGRAM IN THE PHILIPPINES

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Abstract. This study assesses the influence of several malaria risk factors and volunteer health worker (VHW) accessibility on parasite prevalence and treatment-seeking in a remote area of Mindanao, the Philippines. An anti-malaria program in the area seeks to devolve malaria diagnosis and treatment to the VHWs. Firstly, the relationship between malaria and demographic factors, bednet use, and access to treatment was investigated. Secondly, adults from villages with and without resident VHWs were questioned on historical and proposed treatment-seeking for fever and the capacity of the communities to support more health workers was assessed. Parasite prevalence was significantly higher among patients living in villages lacking a resident VHW (adjusted OR=3.88, p=0.02), where proposed delays in consulting VHWs and the official health service, and the use of alternative medicine, were also significantly higher. Kinship or social closeness to VHWs appears to play a role in accessibility. The educational and economic requirements demanded of VHWs impede potential expansion of the program to non-serviced villages. If the effectiveness and equity of community-based treatment strategies is to be increased, increased flexibility allowing use of local, less-educated, drug dispensers needs to be considered.

INTRODUCTION

Malaria control through community-based early diagnosis and treatment is gaining increasing prominence (Nabarro and Tayler, 1998), consistent with current strategies of health-care delivery in poorly-resourced areas (Tolsma and Koplan, 1992). Although volunteer community health workers (VHWs) have successfully delivered anti-malaria therapy in various countries (Kaseje *et al*, 1987; Ghebreyesus *et al*, 1996; Okanurak and Ruebush, 1996), and are cost-effective (Krogstad and Ruebush, 1996; Pagnoni *et al*, 1997; Nabarro and Taylor, 1998; Goodman *et al*, 1999), most malaria mortality still results from a lack of accessible health care and misdiagnosis (World Health Organization, 2000). Treatment-based intervention programs must detect and treat cases early to prevent severe disease and progression to an infectious state (Collins and Jeffery, 1999).

In the Philippines, malaria persists in remote areas with poor public infrastructure and lower population density (Asinas, 1992). The province of Agusan del Sur, on the southern island of Mindanao, is typical. Malaria due to *P. falciparum* and *P. vivax* is endemic in remote semi-subsistence agricultural communities (ADS-MCP Project, 1996). While official malaria-related morbidity and mortality is low, morbidity is greatly under-reported and unevenly distributed (unpublished data). Most of the at-risk population live in small villages grouped into barangays (small districts) of up to 3,000 people. Villages are generally separated by several kilometers of undulating forested country with scattered farms, which may be temporarily or permanently inha-

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bited. Travel, mostly by foot, motorcycle, canoe or raft, is often limited by swollen rivers. Rainfall is high all year round, and the area has numerous small clear streams with suitable habitats for the predominant malaria vector, *Anopheles flavirostris* (ADS-MCP Project, 1997). The vector bites indoors and outdoors, beginning at dusk and peaking near midnight (Torres *et al,* 1997), and close proximity to vector larval habitats significantly increases malaria risk (Foley *et al,* 2003).

Village health workers (VHWs) with basic training in common diseases work from home or from barangay health centers (Lariosa, 1992). They receive three to four days training in malaria control, and are then supervised by travelling midwives based at the Rural Health Units (RHUs) in larger towns. These RHUs usually have a microscopist and serve 20 to 50 barangays. Anti-malarial drugs are not available in village stores, but can be purchased in the larger towns.

Since 1996 the Agusan del Sur Malaria Control and Prevention (ADS-MCP) Project, has trained members of the pre-existing Philippine VHW program in free, symptom-based early case detection and treatment of malaria. The project includes an extensive community education campaign and bednet distribution (ADS-MCP Project, 1996; Miguel *et al,* 1999). Prior to the project, RHUs were the only source of free malaria diagnosis and treatment but access to them is often difficult and prohibitively expensive. Many villagers opted for self-medication with herbs and anti-pyretic drugs or hoarded anti-malarial drugs (Miguel *et al,* 1999). VHWs in the program now treat symptomatic cases with chloroquine free of charge. The VHW's drugs are supplied from the RHU. However, the supply of chloroquine had been inconsistent prior to this study due to problems with procurement and distribution. Recent evidence suggests some resistance to chloroquine exists (ADS-MCP Project, unpublished data).

Nearly two years after community-based early diagnosis and treatment had commenced, surveys of schoolchildren revealed no significant change in parasite prevalence and malaria morbidity rates were unchanged (ADS-MCP Project, 1997). The study reported here aims to investigate this apparent lack of success by measuring demographic and behavioral risk factors associated with malaria parasite prevalence, and assesses the extent to which the strategy of early diagnosis and treatment can be implemented in its present form.

MATERIALS AND METHODS

The study was performed in 2 parts. A survey of people seeking treatment for symptoms consistent with malaria assessed parasite prevalence and the presence of likely risk factors. A further survey then elicited information on treatment-seeking behavior and intentions for the same symptoms.

Associations with parasite prevalence

Five barangays in Agusan del Sur were chosen on the basis of relatively high malaria prevalence, above 5%, in recent surveys of schoolchildren (ADS-MCP Project, 1997). None bordered large towns where anti-malarial drugs could be purchased. VHWs were resident in all barangays, though some villages within them had none.

Patients were recruited during 2 visits approximately 6 weeks apart. Selection criteria consisted of (1) symptoms consistent with local VHW criteria for malaria diagnosis: fever, headache, and chills or rigors within 3 days, or other signs such as pallor (Bell *et al,* 2001); (2) no history of anti-malarial treatment within the previous 4 weeks; and (3) request for treatment. All 357 patients were asked set questions in a local language, usually Visaya, on demographic data, illness duration, and likely risk factors by the same 2 researchers (RG and DB), using VHW interpreters, where necessary. Information gathered on possible confounders included overnight travel within 4 weeks (when transmission leading to acute infection was likely to have occurred), sex, age, occupation, ethnic affiliation, barangay where treated, impregnated bednet use, VHW access time, and presence of VHW within their home village. During the first 2 months, distances between principal dwellings of 271 patients and the nearest potential vector breeding site, shown to be an independent risk factor (Foley *et al,* 2003) were recorded using a

global positioning system and Atlas GIS software (Strategic Mapping, Inc, 1995). House construction was not recorded as all houses were very porous to mosquitos with slat walls, walls missing, or open eaves. Topical repellents were not locally available.

Parasitemia was determined by a positive result on either rapid diagnostic tests (RDT) (ICT Malaria Pf/Pv™, Amrad-ICT, Sydney, Australia) or thick and thin blood films, both of which were assessed on all patients (Bell *et al,* 2001). Chronic infections with sub-patent parasitemias, which would reduce the power to distinguish associations, were probably present (Bell *et al,* 2001).

Treatment-seeking behavior and VHW demography

To investigate treatment-seeking behavior, a further survey was conducted in 4 villages included in the earlier survey of parasite prevalence 6 months after adequate drug supply to VHWs and improved diagnosis with RDTs had been established. Paired villages were chosen from 2 different barangays, 2 were without resident VHWs (one receiving brief VHW visits every 1 to 2 months) and 2 villages adjacent to them (25-45 minutes walking distance) had resident VHWs. The paired villages were matched by ethnic affiliation and predominant occupational activity, had similar geography and were similar distances from larger towns. There had been no significant differences between them in activities related to malaria control in the previous 2 years apart from activities directly related to VHW presence (bednet distribution, education, and diagnosis and treatment availability). Relative malaria prevalence and incidence prior to the ADS-MCP Project was not known.

Every house in the smaller villages and every second or third in the larger was visited. This systematic sampling reduced the probability of over-sampling certain family groups, who commonly live in adjacent houses. The first available resident adult of each household was asked to participate. If no adult was present, the next house was visited. A bias towards females was inevitable as males are commonly away from the house during the day. The same two researchers (RG and DB) administered 72 questionnaires

Table 1
Vignettes used in interviews.

i).   Junmar is a young married man who lives in a village the same as this. He is usually well and works on the farm. He has had some fever for the past 3 days and felt a bit sick, but has been able to work. Last night he had a headache which made it hard to sleep, and had chills early this morning. Now he feels better but still has a mild fever.

ii).   Marevic is a young married woman who lives in a village similar to this. She has 3 young children, and is normally healthy. Her husband has gone to work on the farm for a few days. She is home with the children. She had a fever with a mild headache and chills 3 days ago, but was still able to work and it got better. Today she has a mild fever again.
        What do you think *she* should do now?
        If *she* still has fever tomorrow, what should *she* do then?
        If *she* is still not better, what should *she* do then?
        ..... repeat until no more answers.

using a standard Visaya text; there were no refusals. Respondents were questioned on personal history of fever and treatment-seeking during the previous 12 months, and on demographic data. Proposed treatment-seeking was assessed by alternating 2 vignettes describing patients with mild malaria symptoms (Table 1). Respondents were asked their daily treatment preferences until visiting a VHW or other health service provider was proposed. This format was considered less threatening than questioning of personal intentions (Finch, 1987).

A simple semi-quantitative economic assessment was limited to house quality, as varying household size, the semi-subsistence economy and sensitivity regarding personal finances made a more detailed economic assessment inappropriate. Houses, all of which were very porous to mosquitoes, were rated '1' for a solid floor, all external walls present, >3 rooms, and good-quality furniture, to '3' for a dirt or bamboo floor, poor-quality or missing walls, few rooms and minimal furniture. It was considered that this would have given an approximation of economic prosperity in this society, although accuracy is limited.

Interviews with 27 of the 35 VHWs active in

the 5 barangays in the study area were conducted in Visaya or English (RG and DB), asking opinions on main reasons for patient non-attendance, effects of rapid diagnosis on work and patient behavior, and positive and negative aspects of their work. There was 1 refusal, and 7 VHWs were absent. All household and VHW questionnaires were back translated, and pretested.

Analysis

Data entry and basic analysis was performed with Epi Info 6.04c (Dean *et al,* 1997). Crude means were compared using the Kruskall-Wallis non-parametric test. Multivariate analysis using binary logistic regression was performed using SPSS 9.0.1 (SPSS Inc, 1999), and the Wald chi-square statistic was used to assess the significance of odds ratios (OR). Comparisons of adjusted means are presented as mean $\forall 95^{th}$ percentile intervals. Larval habitat distance in the parasitemia survey was entered as 50m, >50m, and unmapped categories, as 50m had the strongest correlation with risk of parasitemia (Foley *et al,* 2003) and inclusion of unmapped cases did not alter the direction or significance (p=0.05) of any other associations (Greenland and Finkle, 1995). Answers to questionnaires were grouped according to subject and key words, and summarized.

Ethical considerations

Informed written consent was obtained from all participants or adult guardians. Ethical clearance was obtained from the Research Institute for Tropical Medicine, Manila and the Queensland Institute of Medical Research, Australia.

RESULTS

Survey of parasite prevalence in symptomatic people

Data were included on 350 patients. Seven further incomplete records were excluded. Mean age was 19.5 years (median 13, range <1 to 76), and parasitemic patients tended to be younger (adjusted means 17.1 years, CI 15.0-19.3, *vs* 22.9 years, CI 20.4-25.5, p=0.001). Parasite prevalence was significantly higher in children (Table 2). Males comprised 48.9% of patients. Parasite prevalence was similar in both sexes

(Table 2). Ethnic affiliation and occupation (which varied with age and sex) had no significant association with parasite prevalence (Table 2).

Although many residents (44.9%) had travelled away overnight in the previous 4 weeks when inoculation with the present infection was most likely, parasite prevalence was unaffected by travel history (Table 2). Most travel was within the same (55.4%) or to nearby barangays (35.7%), and most travellers were older residents and farmers.

The two villages with no resident VHW had a significantly higher parasite prevalence than the villages with resident VHWs (Table 2). This relationship remained significant when analysis was restricted to the villages without residents VHWs and the 2 adjacent villages with resident VHWs, which were in close proximity and had similar ethnic affiliations (adjusted OR=16.9, CI 2.6-109.8, p<0.01). Travel time to the nearest VHW was not an independent risk factor (Table 2). This association with VHW presence remained significant when stratified individually by all the variables listed below Table 2.

Treated bednets were present in all barangays, and reportedly used by 85.1% of patients, 90.3% of whom stated they used them "always". Only 49 of these patients (18%) always used nets treated with insecticide within 6 months (including new nets). Bednet use was more common in villages where VHWs were resident (88.0% *vs* 61.3%, χ^2 = 6.92, p<0.01), and in younger age groups. Parasite prevalence was the same among those always using treated nets (57.1%, n=49), and those with no bednets (57.7%, n=52); adjusted OR=0.68, p=0.57. Comparison of non-net users and the other categories of net use above failed to reveal a significant relationship (p>0.35 in all categories).

History of treatment-seeking for fever

Forty-nine adult household members (34 females) were recruited, 1 per household, from the 2 villages with resident VHWs, and 23 (15 females) from the 2 nearby villages without VHWs (of an estimated 174 and 59 households, respectively), with a mean age of 38 years (range 15 to 80). Most were farmers (43) or housekeepers (26, all female).

A history of fever within the past 12 months

was reported by 55 (76%) of the 72 respondents. In the 2 villages with resident VHWs, only 49% (18) of these had failed to access anti-malarial drug therapy at least once, compared to 72% (13) in the villages without VHWs (p=0.10). "Lack of medicine" was the only reason that all 18 people in the villages with a resident VHW failed to visit the VHW, while "distance" (7) and "lack of medicine" (7) were predominant reasons for access failure in villages without VHWs. Some respondents had not verified drug availability with the VHWs. Medication was obtained from family members or purchased in towns by 24% (12) of respondents from villages with VHWs and by 17% (4) from villages without.

Treatment-seeking behavior of hypothetical patients

The official health services (VHW/HS) were included by 70 of the 72 respondents in their proposed treatment pathway for fever (Table 3); 54 chose VHWs or midwives and 16 chose RHUs. The mean delay in VHW/HS access among these was 2.3 days (median 1, range 1 to 8 days), with a mean of 4.6 and 3.1 days in the 2 villages without VHWs and 2.2 and 1.4 in villages with VHWs in residence (χ^2 = 15.5, p<0.01). Only 44% (38% and 54%) of respondents from villages with no resident VHW proposed access within 3 days, compared to 88% (79% and 96%) from the 2 villages with VHWs (χ^2= 15.8, p<0.01). Delays were unaffected by sex or the vignette used.

Lack of a resident VHW was the only independent risk factor associated with both failure to immediately resort to VHW/HS (5/23 vs 35/49 respondents, Table 4), and utilization of the

Table 2

Associations in *P. falciparum or P. vivax* parasitemia (demonstrated by rapid diagnostic test or microscopy) of 350 symptomatic patients.

		n	Crude		Adjusted[a]		
			para %	p	OR	p	95% CI
Away overnight in past	N	193	62.2	0.13	1.00		
4 weeks	Y	157	54.1		1.06	0.85	0.60 - 1.84
Sex	M	171	59.1	0.85	1.00		
	F	179	58.1		0.88	0.62	0.52 - 1.48
Age	>16 yr (adult)	147	47.6	<0.01	1.00		
	≤16 yr (child)	203	66.5		8.24	0.04	1.13 - 60.10
Occupation[b]	None	108	67.6	0.02	1.00		
	Farmer	118	50.0		3.03	0.27	0.41 - 22.19
	Student	96	63.5		0.75	0.41	0.38 - 1.48
	Housekeeper	21	42.9		0.94	0.96	0.10 - 8.76
Bednet use							
(Always, treated)	N	301	57.1	0.93	1.00		
	Y	49	58.8		0.80	0.57	0.38 - 1.71
VHW access time	≤15 minutes	273	56.0	0.32	1.00		
	>15 minutes	77	62.3		1.47	0.53	0.44 - 4.92
Relationship to	VHW village	207	49.3	<0.01	1		
VHW village	Outlying farms[c]	58	55.2		0.47	0.22	0.14 - 1.55
	Non-VHW village	85	83.5		3.88	0.02	1.19 - 12.59

[a]Adjusted values after binary logistic regression against overnight travel, sex, age (16 years), occupation, ethnic affiliation, barangay where treated, impregnated bednet use, VHW access time, presence of VHW in home village, and distance (50m) from vector larval habitat.
[b]7 cases had other occupation (3 were parasitemic). Occupation "none" indicates predominantly young people not in school; 96.3% were 16 years of age.
[c]The two VHW-resident villages had outlying farms with permanent dwellings. The villages without VHWs did not.
para %: percent parasite prevalence.   OR: Odds ratio.   95% CI: 95% confidence intervals.

Table 3

Sequences of treatment choices suggested by 72 respondents for hypothetical patients with symptoms consistent with malaria.

Step 1	Step 2	Step 3	Step 4	n
HS[a]				40
Herbal	HS			14
Herbal	Massage	HS		1
Herbal				1
Buy unspec med[b]	HS			6
Buy unspec med	Herbal	HS		1
Rest	HS			2
Rest	Herbal	HS		1
Rest	Herbal	Buy unspec med	Pray	1
Rest	Buy unspec med	HS		1
Eat	Herbal	HS		2
Buy anti-malarial[c]	HS			1
No action[d]	HS			1

[a]HS: Health Service (VHW, midwife or RHU).
[b]Purchase of unspecified medication (including anti-pyretic drugs).
[c]Purchase of anti-malarial medication specifically.
[d]Respondent proposed no change in normal activity for first 2 days.

Table 4

Preferred treatment-seeking behavior for hypothetical patients with fever given in response to one of two clinical vignettes by 72 adult household members. Associations with choice of Barangay Health Worker or Health Service (VHW/HS) as first treatment option, adjusted by binary logistic regression for the variables listed. OR = odds ratio.

| | | VHW/HS First | | |
		OR	95% CI[a]	p
Sex	F : M	0.43	0.11 - 1.65	0.22
Age[b]	per prev year	1.02	0.98 - 1.07	0.52
Eco[b,c]	per prev increment	0.74	0.26 - 2.10	0.57
Edu[b,d]	per prev year	0.86	0.70 - 1.06	0.16
Village	No VHW : VHW	12.14	2.70 - 54.62	0.001
Vignette	2 : 1	1.14	0.37 - 3.49	0.82

[a]95% confidence intervals.
[b]Age and Eco (economic status) coded as continuous variables, OR refers to previous increment (or year).
[c]Eco : Economic status as assessed by housing standard rated 1(high) to 3 (low).
[d]Edu: Education as year level of schooling completed.

main alternative, herb-based remedies (13/23 *vs* 8/49, OR = 0.16, p = 0.02). Proposed herb use was associated with a mean VHW/HS access delay of 4.2 days (median 4), 2.5 days longer than others (χ^2 =30.66, p <0.001), and exceeded 3 days in 63% compared to 10% in others (Fisher-exact p < 0.001). Herbs were more popular among women (39% *vs* 9%, OR = 10.8, p = 0.02), while men tended to propose purchasing medicines (22% *vs* 10%, OR = 2.44, p = 0.19). Educational attainment did not significantly influence choices.

Demography of communities and VHWs

The 72 respondents above represented 149 household members in villages without VHWs and 255 in villages with VHWs (range 2 - 15 members, 51.5% female). Households in villages without VHWs were larger than either village with VHWs (mean 8.0 people in the former *vs* 6.1 in the latter, χ^2 = 28.3, p <0.01). Both of the former villages had proportionately more children [combined child (#16) to adult ratio 1.16 *vs* 0.82, χ^2 = 2.80, p = 0.09].

The mean educational level of adults >20 years was lower in both villages with no VHW than either village with (combined mean 3.2 years, *vs* 5.3 years respectively, χ^2 = 21.3, p <0.01). The former villages also had lower economic (housing) standards than either village with VHWs (2.3 *vs* 2.8 respectively, χ^2 = 13.2, p <0.01).

All 27 VHWs interviewed were female with ages ranging from 25 to 50, including 11 from the 2 villages discussed above. Their mean household size (6.1) was typical of their villages. The mean VHW education level was relatively high (6.8 years), and the 11 from villages included in the community survey were significantly better educated than their fellow villagers (7.6 *vs* 5.3 years, p = 0.01).

DISCUSSION

The high parasite prevalence in children, and lack of influence of overnight travel, indicate that most malaria transmission occurs within villages. The combination of lower parasite prevalence and proposed earlier access to VHWs in villages with resident VHWs provides persuasive evidence that ready access to VHWs dispensing anti-malarial therapy, and perhaps the health education which they provide, is primarily responsible for the marked reduction in malaria parasite prevalence in these villages. Other factors had little influence; the poor efficacy of bednets may reflect the biting habits of the main vector (ADS-MCP Project 1997; Torres *et al*, 1997) and are consistent with observations elsewhere in the Philippines (Lansang *et al*, 1997).

Parasite prevalence remained low among residents of the outlying farms surrounding the villages with resident VHWs, which commonly share family ties with them. However, the effect of VHW presence was greatly diminished in villages at similar distances and with similar geographical access, but in which no VHW was resident. Kinship with, or social distance from, VHWs therefore appears as an important determinant of VHW utilization as geographical distance, consistent with observations elsewhere (Ettling *et al*, 1989; Konradsen *et al*, 2000). The great predominance of females does not appear to deter males from accessing services. No reports were received of informal payments to VHWs.

Interestingly, utilization of alternative therapies appears to result from poor access to VHWs, rather than being a primary cause of treatment delay. The high use of herbal therapy by women, and other alternative therapies by men, in preference to early VHW access was associated with villages where no VHWs were resident, and these villages had similar ethnic and cultural backgrounds to those with VHWs. Although education levels were lower, education was not an independent determinant of VHW utilization. As elsewhere in the Philippines (Espino and Manderson 2000), traditional healers did not figure in decision-making for treatment of malaria symptoms.

"Lack of medicine" was still a major reason for poor treatment-seeking, despite 6 months of reliable supply, probably reflecting both historical lack and the continuing assumption of poor health service delivery stemming from this, and emphasizing the importance of providing such a community-based delivery system with reliable logistical support. The association of poor treatment-seeking with lower economic status suggests that the cost-recovery scheme may not be effective in addressing this.

Nearly all respondents from villages without VHWs eventually proposed VHW access for malaria symptoms in the vignettes. Therefore, does the delay of a couple of days in proposed access really matter? The higher parasite prevalence in these villages, and lower VHW utilization in fever histories, suggests that it does. Symptoms of malaria in Agusan del Sur are commonly mild (Bell *et al*, 2001), and folk definitions of malaria have very poor sensitivity (Lariosa

1986; ADS-MCP Project 1996; Espino *et al*, 1997; Miguel *et al*, 1999). Therefore, while symptoms are likely to persist beyond the mean delay proposed in the villages with resident VHWs, the longer delays in the other villages increase the likelihood that symptoms will resolve either spontaneously or with the help of anti-pyretics and herbs. This will remove the incentive to seek further treatment and result in progression to an asymptomatic, infectious state (Collins *et al*, 1999).

The mean treatment delay of only 2-3 days proposed in VHW villages in Agusan del Sur is consistent with that achieved elsewhere (Rooth and Bjorkman, 1992; Konradsen *et al*, 2000). However, the results suggest that the control program will not achieve significant improvement in malaria prevalence unless easier access to definitive therapy is provided to the unserviced villages. These villages appeared economically poorer, and as evidence from elsewhere in the Philippines indicates that compliance is lower when drugs are purchased privately (Lariosa, 1986; Espino *et al*, 2000), extension of the free dispensing system is required. However, the poor economic and educational standards in these villages may impede expansion of the VHW system as costs of VHW travel can be high, and the high level of literacy required is reflected in the higher than average education level of existing VHWs.

This study illustrates both the potential and the limitations of basing an early case detection and treatment program for malaria on an existing network of trained multi-function health workers. The problems encountered will be common to many remote malaria-endemic areas. Modification through the use of illiterate malaria treatment dispensers appears necessary, and such workers have been used successfully elsewhere (Kaseje *et al*, 1987; Ruebush *et al*, 1990). Apprehension regarding diagnostic and treatment errors of lesser-trained dispensers (unpublished data) could be addressed by a clear system of referral, pictorial record keeping (Ruebush *et al*, 1990), and through the use of blood-based rapid diagnostic tests used successfully by VHWs in the study area (Bell *et al*, 2001). Attention to family and social ties when recruiting treatment-dis-

pensers will further improve access to treatment.

REFERENCES

ADS-MCP Project. Annual project review: Implementation and evaluation of a self-sustaining community-based malaria control program in hyperendemic areas of Agusan del Sur. Alabang, City of Muntinlupa: Research Institute for Tropical Medicine, Department of Health, Republic of the Philippines, 1996.

ADS-MCP Project. Second annual project review: Implementation and evaluation of a self-sustaining community-based malaria control program in hyperendemic areas of Agusan del Sur. Alabang, City of Muntinlupa: Research Institute for Tropical Medicine, Department of Health, Republic of the Philippines, 1997.

Asinas CY. Current status of malaria and control activities in the Philippines. *Southeast Asian J Trop Med Public Health* 1992; 23 (suppl 4): 55-9.

Bell D, Go R, Miguel C, Walker J, Cacal LP, Saul A Diagnosis of malaria in a remote area of the Philippines: comparison of rapid diagnosis, microscopy and symptom-based diagnosis and their acceptance by the community. *Bull WHO* 2001; 71: 933-41.

Collins WE, Jeffery GM. A retrospective examination of sporozoite- and trophozoite-induced infections with *Plasmodium falciparum*: development of parasitologic and clinical immunity during primary

infection. *Am J Trop Med Hyg* 1999; 61: 4-19.

Dean AG, Dean JA, Coulombier D, *et al.* Epi Info, Version 6: A Word-Processing, Database and Statistics Program for Public Health on IBM-compatible Microcomputers. 6.04c. Atlanta: Centers for Disease Control and Prevention, 1997.

Espino F, Manderson L. Treatment seeking for malaria in Morong, Bataan, the Philippines. *Soc Sci Med* 2000; 50: 1309-16.

Espino F, Manderson L, Acuin C, Domingo F, Ventura E. Perceptions of malaria in a low endemic area in the Philippines: transmission and prevention of disease. *Acta Trop* 1997; 63: 221-39.

Ettling MB, Thimasarn K, Krachaiklin S, Bualombai P. Malaria clinics in Mae Sot, Thailand: factors affecting clinic attendance. *Southeast Asian J Trop Med Public Health* 1989; 20: 331-40.

Finch J. Research Note: The Vignette Technique in survey research. *Sociology* 1987; 21: 105-14.

Foley DH, Torres EP, Mueller I, Bryan JH, Bell D. Host-dependent mosquito larval distribution reinforces the risk of malaria near water. *Trans R Soc Trop Med Hyg* 2003; 97: 283-7.

Ghebreyesus TA, Alemayehu T, Bosman A, Witten KH, Teklehaimanot A. Community participation in malaria control in Tigray region, Ethiopia. *Acta Trop* 1996; 61: 145-56.

Goodman CA, Coleman PG, Mills AJ. Cost-effectiveness of malaria control in sub-Saharan Africa. *Lancet* 1999; 354: 378-85.

Greenland S, Finkle WD. A critical look at methods for handling missing covariates in epidemiologic regression analyses. *Am J Epidemiol* 1995; 142: 1255-64.

Kaseje DC, Spencer HC, Sempebwa EK. Characteristics and functions of community health workers in Saradidi, Kenya. *Ann Trop Med Parasitol* 1987; 81 (suppl 1): 56-66.

Konradsen F, Amerasinghe PH, Perera D, van-der-Hoek W, Amerasinghe FP. A village treatment center for malaria: community response in Sri Lanka. *Soc Sci Med* 2000; 50: 879-89.

Krogstad DJ, Ruebush TK. Community participation in the control of tropical diseases. *Acta Trop* 1996; 61: 77-8.

Lansang MA, Belizario VY, Bustos MD, Saul A, Aguirre A. Risk factors for infection with malaria in a low

endemic community in Bataan, the Philippines. *Acta Trop* 1997; 63: 257-65.

Lariosa TR. Culture, environment and people's perceptions: considerations in malaria control in the Philippines. *Southeast Asian J Trop Med Public Health* 1986; 17: 360-70.

Lariosa TR. The role of community health workers in malaria control in the Philippines. *Southeast Asian J Trop Med Public Health* 1992; 23 (suppl 1): 30-5.

Miguel CA, Tallo VL, Manderson L, Lansang MA. Local knowledge and treatment of malaria in Agusan del Sur, The Philippines. *Soc Sci Med* 1999; 48: 607-18.

Nabarro DN, Tayler EM. The "Roll Back Malaria" campaign. *Science* 1998; 280: 2067-8.

Okanurak K, Ruebush TK. Village-based diagnosis and treatment of malaria. *Acta Trop* 1996; 61:157-67.

Pagnoni F, Convelbo N, Tiendrebeogo J, Cousens S, Esposito F. A community-based programme to provide prompt and adequate treatment of presumptive malaria in children. *Trans R Soc Trop Med Hyg* 1997; 91: 512-7.

Rooth I, Bjorkman A. Fever episodes in a holoendemic malaria area of Tanzania: Parasitological and clinical findings and diagnostic aspects related to malaria. *Trans R Soc Trop Med Hyg* 1992; 86, 479-82.

Ruebush TK, Zeissig R, Godoy HA, Klein RE. Use of illiterate volunteer workers for malaria case detection and treatment. *Ann Trop Med Parasitol* 1990; 84: 119-25.

SPSS Inc. SPSS for Windows. 9.0.1. Chicago: SPSS Inc, 1999.

Tolsma DD, Koplan JP. Health behaviour and health promotion. In: Maxcy-Rosenau-Last public health and preventive medicine. 13th ed. East Norwalk: Prentice-Hall International, 1992.

Torres EP, Salazar NP, Belizario VY, Saul A. Vector abundance and behaviour in an area of low malaria endemicity in Bataan, the Philippines. *Acta Trop* 1997; 63: 209-20.

World Health Organization. Roll Back Malaria. A global partnership. Geneva: World Health Organization, 2000. Available from: URL: http://www.who.int/rbm/about.html.