A number of studies have discussed different kinds of strategies for improving health-worker performance. A recent review reported that the simple dissemination of written guidelines is usually ineffective, supervision and audit with feedback is generally quite effective, and multi-faceted approaches (e.g., training plus supervision) may be more effective at changing practices than single-component interventions [13]. The importance of supervision is particularly emphasized because it can improve performance at least in the short-term [22], provide professional development, and improve health workers' job satisfaction and motivation [23].

One possible strategy to expand the range of VMWs' services and to improve their actions and knowledge would be to strengthen the VMW training curriculum. Since most of the VMWs were able to accomplish what they had learned in VMW trainings, there is a good possibility that improved training programmes could achieve wider service range and higher service quality. Although VMWs' services have been focused on diagnosis and treatment so far, they should be expanded to other aspects of malaria control, including prevention and vector control. In fact, regression analyses of this study demonstrated that knowledge of malaria transmission and that of vector ecology, especially regarding vector breeding places, are significant determinants for both VMWs' service quality and actions for malaria control. This is possibly because overall understanding of malaria control, including both malaria epidemiology and vector ecology, is necessary to provide better service quality and more actions. In order to further promote community-based malaria control in Cambodia, the range of VMWs' services should be widened to cover more aspects of malaria control, and VMWs should take the initiative in conducting a greater variety of measures for malaria prevention and vector control.

Specifically, the current VMW training curriculum can be improved by: 1) making its contents easier to understand for VMWs with limited education (three years of school education on average), especially technical terms, tables, and figures in flipcharts, leaflets, and handouts, 2) including a variety of topics regarding malaria and vector control, and 3) adding more participatory activities to provide hands on experience. Although there is a need to break away from an old paradigm that performance can be improved by training alone [13], some modifications in the curriculum and inclusion of more participatory activities in the training could lead to the acquisition of accurate knowledge and skills among VMWs in the long run. Further research is now underway to examine the effectiveness of a new training programme developed based on the results of this study in achieving higher VMW service quality.

As described in previous studies [13,22,23], strengthening supervision in combination with modifying the training curriculum might be effective in improving VMWs' service quality. Currently, supervision is conducted by the CNM staff in two ways: monthly meetings at health centers in each region and village visits twice a year. In monthly meetings, CNM staff check VMWs' records of fever cases and RDT positive cases, and resupply RDT kits and anti-malarials. They also visit each VMW village twice a year to directly monitor VMW activities and observe their relationship and communication with villagers. In addition to these components of current supervision, providing VMWs with opportunities to review their knowledge of malaria control (especially prevention) and to share their experiences and challenges could be an effective means to improve their knowledge and motivation. Also, increasing the frequency of village visits could facilitate professional development and improve the two-way flow of information between VMWs and the central government.

Some limitations of this research must be taken into account when interpreting study findings. To evaluate VMWs' service quality, only self-reported data were used, and actual villagers' experiences were not taken into account. This limitation can partly be covered by another recent study, which examined VMWs' service quality using data obtained from villagers. The validation of self-reported indices regarding service quality and action needs improvement. However, possible attempts were made: for example, self-reported data were double-checked with VMWs' records in their monthly reports, which are submitted to the CNM regularly. In addition, objective information about VMWs' service quality was obtained from local health workers as much as possible.

Several Asian and African countries are currently investing in community health workers as a major part of their strategies to reach the Millennium Development Goals [18]. For example, nearly 25,000 community health workers have been trained in Ethiopia and are delivering family planning, immunization, and health education to their communities [24]. In India, state-wide community health worker programmes are under way as a part of the National Rural Health Mission. Furthermore, several trials have been carried out to expand community health workers' roles. For example, the role of 54,000 women community volunteers in India evolved over time into two different sets of activities: one focuses on child survival and the other on women's empowerment and community action [25]. Also, a trial to expand Cambodian VMWs' role to the management of diarrhoea and acute respiratory diseases started in 2005 [11]. Since there is substantial interest in the potential contributions of community health workers to reach the Millennium Develop-

ment Goals, it is timely and vital to examine their performance and propose effective strategies to support them in their work and to improve the quality of their services in different settings.

Conclusions

This study has demonstrated that Cambodian VMWs' services focused narrowly on diagnosis and treatment, and that their knowledge of malaria epidemiology and vector ecology as well as actions for malaria prevention and vector control require substantial improvement. Knowledge of malaria transmission and that of vector breeding places were found to be significant determinants of both VMWs' service quality and actions for malaria prevention and vector control. In addition to diagnosis and treatment, which have been the focus of VMWs' services so far, more aspects of malaria control should be covered in their training to further promote community-based malaria control in the country.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

JY conceived the study, developed the questionnaire, analysed data, and wrote the manuscript. KCP contributed to the study design, trained surveyors, conducted fieldwork, and improved the manuscript. KPT entered and analysed data and improved the manuscript. CN, PL, and DS supervised fieldwork. MJ monitored the study progress and provided guidance to improve the manuscript. All authors read and approved the final draft.

Acknowledgements

We would like to acknowledge the contribution of the field work team: Dr. Sok Vanne, Dr. Srey Socheat, and Dr. Kim Marath. We also thank all the VMWs who participated in the survey. We are grateful to Dr. Anne M. Johnson for her helpful advice on the manuscript. This study was supported by the Grant for International Health Cooperation Research (19C-1) from the Ministry of Health, Labour and Welfare of Japan.

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Received: 9 October 2009 Accepted: 23 April 2010
Published: 23 April 2010

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doi: 10.1186/1475-2875-9-109
Cite this article as: Yasuoka *et al.*, Assessing the quality of service of village malaria workers to strengthen community-based malaria control in Cambodia *Malaria Journal* 2010, **9**:109

MALARIA JOURNAL

RESEARCH Open Access

School-based participatory health education for malaria control in Ghana: engaging children as health messengers

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Abstract

Background: School children have been increasingly recognized as health messengers for malaria control. However, little evidence is available. The objective of this study was to determine the impact of school-based malaria education intervention on school children and community adults.

Methods: This study was conducted in the Dangme-East district of the Greater Accra Region, Ghana, between 2007 and 2008. Trained schoolteachers designed participatory health education activities and led school children to disseminate messages related to malaria control to their communities. Three schools and their respective communities were chosen for the study and assigned to an intervention group (one school) and a control group (two schools). Questionnaire-based interviews and parasitological surveys were conducted before and after the intervention, with the intervention group (105 children, 250 community adults) and the control group (81 children, 133 community adults). Chi-square and Fisher's Exact tests were used to analyse differences in knowledge, practices, and parasite prevalence between pre- and post-intervention.

Results: After the intervention, the misperception that malaria has multiple causes was significantly improved, both among children and community adults. Moreover, the community adults who treated a bed net with insecticide in the past six months, increased from 21.5% to 50.0% ($p < 0.001$). Parasite prevalence in school children decreased from 30.9% to 10.3% ($p = 0.003$). These positive changes were observed only in the intervention group.

Conclusions: This study suggests that the participatory health education intervention contributed to the decreased malaria prevalence among children. It had a positive impact not only on school children, but also on community adults, through the improvement of knowledge and practices. This strategy can be applied as a complementary approach to existing malaria control strategies in West African countries where school health management systems have been strengthened.

Background

Ghana is located in sub-Saharan Africa, where an estimated 90% of the world's malaria-attributable deaths occur. In Ghana, malaria accounts for more than 44% of reported outpatient visits and an estimated 22% of deaths in children under the age of five. Reported malaria cases represent only a small proportion of the actual number of episodes, as the majority of people with symptomatic infections are treated at home and are, therefore, not often reported [1,2]. In Ghana, the national malaria control programme focuses chiefly on pregnant women and children under five years of age, as malaria leads to more serious consequences in this group. The main activities of the malaria control programme in Ghana are facility-based and implemented at the health centre level, i.e., providing intermittent preventive treatment (IPT) and distributing insecticide-treated bed nets (ITNs) to pregnant women during antenatal care, and distributing ITNs to women with young children during immunization [3].

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Children of school-going age have also been targeted for malaria control in some endemic countries including Ghana [4-6]. As more and more children attend school, governments are increasingly recognizing the importance of child health for educational achievement [7]. A number of studies that focus primarily on evaluating the effectiveness of providing treatment for children have been conducted in the school setting, [5,8,9]. Recently, the impact of IPT among school children has drawn increased attention [10-12]. However, while IPT is relevant only in high-transmission areas, skills-based health education for malaria control is recommended to be effective in all transmission settings [13].

Recently, school-based health education interventions have been conducted for malaria control. They use an innovative approach that engages school children to reach community adults with health messages and hygienic practices through action-oriented and participatory learning action (PLA). For example, Okabayashi *et al* [14] reported that school children disseminated information on malaria to the community through a variety of approaches including issuing newsletters, placing billboards, and holding village events in Thailand. As a result, both children and community adults showed improved knowledge, attitudes, and practices pertaining to malaria. Onyango-Ouma *et al* [15] evaluated the potential of school children as health change agents in a rural community in Kenya and observed improved knowledge pertaining to malaria among children and guardians. In Lao PDR, Nonaka *et al* [16] demonstrated that school children reached out to and influenced women who were not caregivers of target school children to improve their behaviour in relation to malaria control. These studies consistently reported that school children were not merely recipients of health education, but also contributed to malaria control by playing the role of health change agents in the community. In the present study, this approach was employed in a different area in order to confirm the effectiveness of the strategy, with the consideration that socio-cultural factors in the different area might influence its effectiveness.

The West African Centre for International Parasite Control (WACIPAC) was established at the Noguchi Memorial Institute for Medical Research of the University of Ghana in 2004, with support from the Japan International Cooperation Agency. As part of the strategy to control parasitic diseases in the West African sub-region of sub-Saharan Africa, the WACIPAC set up a parasite control project model site in the Ada-Foah sub-district of the Dangme-East District to facilitate capacity building and evaluate intervention strategies. In this study, the objective was to determine the impact of school-based malaria education intervention, not only on children but also on adult community members.

Methods

Study site

The study was conducted in the Dangme-East District of the Greater Accra Region, Ghana, between July 2007 and June 2008. Dangme-East District is located approximately 100 km east of the capital, Accra. The district is partially rural and partially urban in nature and covers an area of 721 km^2. The indigenous Ga-Dangme people form the majority of the residents in the area. According to the nation's 2000 census, the population of the district is 93,193. Annual rainfall ranges between 740 and 900 mm. The highest and lowest mean monthly temperatures are approximately 30°C and 26°C, respectively. The relative humidity throughout the year ranges between 65 and 80%. The region's vegetation is basically coastal savannah, consisting of grass with isolated patches of trees and shrubs. There are wet and dry seasons; the wet season begins in May and ends in October. The district has four government-run health centres and a district hospital. According to the data available at the District Health Office, in 2006, the malaria prevalence of clinically diagnosed and laboratory-confirmed cases among outpatients in the district was 45.0% (19,273/42,974).

In collaboration with local education and health authorities, three primary schools (Afiadenyigba, Dorgobom and Tojeh) were purposively selected from the 15 located within the Kasseh-East Circuit of the Dangme-East District Education Directorate of the Ghana Education Service. The selection was based on specified criteria including: similar ecological setting, school master's willingness to participate in the study, and school master's recognition of malaria as one of the major problems affecting school children. The selected schools are located within several kilometres of each other, in rural settings (Figure 1). The Afiadenyigba village and school

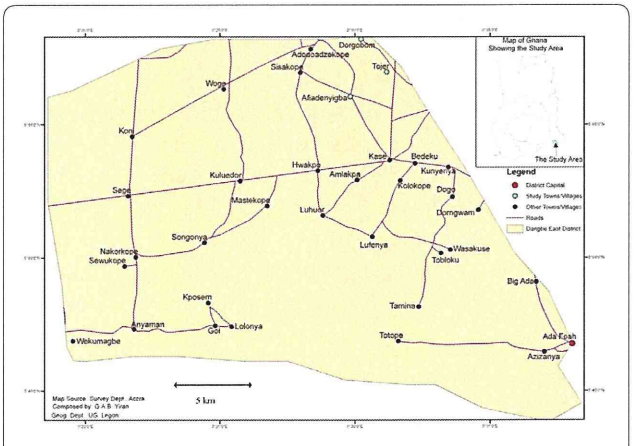

Figure 1 Map of the Dangme-East District showing the study villages. Small map inserted at the upper right shows Ghana; Dangme-East District is highlighted in green. Green circles indicate the locations of the study villages and schools (Afiadenyigba, Dorgobom and Tojeh).

served as the intervention area whilst the Dorgobom and Tojeh villages and schools were used as controls. According to the sample size calculation, approximately one hundred children were required in each of the intervention and control groups. As neither the Dorgobom nor Tojeh schools had enough children to reach the required sample size, the two control schools and their respective communities were grouped as one.

Study populations

The study population consisted of 186 children in grades 3-5 from the selected schools and 383 adults who resided in villages where the schools are located. School children in the first and second grades were excluded due to perceived difficulties in involving them in the intervention. For community adults, an attempt was made to invite one adult participant from each household of the villages where the schools are located. In recruitment of adult participants, priority was given to those that were caregivers of children at the target school; in case there were no household members who were caregivers of target school children, priority was given to caregivers of non-target children or any woman of reproductive age.

Intervention

Teacher training

The health education intervention started from October 2007. At the beginning of the intervention, a two-day training was conducted for all teachers at the intervention school. On the first day, malaria-related information was shared, such as mosquito biology, malaria signs and symptoms, and treatment and prevention. Additionally, teaching methods using PLA were introduced. On the second day, strategies for effective implementation of malaria education activities in the schools and villages were discussed. Finally, teachers developed action plans for the health education intervention (See Additional file 1).

Post-teacher training activities

The research team (IA, DN, JKA, and SH) provided picture charts and posters on malaria transmission and prevention, which were requested by teachers and used in teaching children in the participating grades. The posters were displayed on the walls of their classroom after teaching. Teachers guided the children through dramatizing the transmission of malaria and prevention methods. The teachers then led the children to observe their school compound and cleared possible mosquito breeding sites such as open cans and dumped containers. The children were also encouraged to draw pictures on malaria according to their understanding of the malaria education they received and voluntarily use the pictures to educate their peers and adults in the village. The teachers composed a song in the local language (Ga-Dangme) on malaria entitled 'pumi (mosquito) song', to educate the children and community on malaria transmission and prevention. The song, which became popular, was aimed at correcting common misperceptions that eating green mangoes or standing in the sun gives malaria and it promoted the use of bed nets for preventing mosquito bites and malaria transmission. The teachers made slogans such as "mosquito: malaria provider" which the children happily chanted at school and in the village. These activities were mainly conducted in the morning before the day's lessons.

Campaign

In February 2008, the teachers and 3rd to 5th grade children of the intervention school also conducted a one-day anti-malaria campaign in which they educated the village residents on malaria through a number of recreational activities. First, they marched through the village singing the 'pumi song' accompanied by the school band, at which time they invited community members to their school compound for a durbar. At the gathering, the children educated the people about malaria through drama and poetry recitals. A community health nurse demonstrated the correct procedure for treatment of conven-

Table 1: Characteristics of school children.

Characteristic	Intervention school (n = 105)	Control schools (n = 81)	p-valuea
Age (yrs), median (range)	13 (8--20)	12 (8-21)	0.132[b]
Sex, male/female	59/46	44/37	0.799
Grade: n (%)			0.598
3rd	35 (33.3)	31 (38.3)	
4th	37 (35.2)	23 (28.4)	
5th	33 (31.4)	27 (33.3)	

[a], Chi-square test
[b], Mann-Whitney U test

Table 2: Characteristics of the community adults.

Characteristic	Community Adults		
	Intervention village (n = 250)	Control villages (n = 133)	p-valuea
Age(yrs), median (range)	35.0 (16-93)	35.5 (18-85)	0.504[b]
Sex, male/female	9/241	8/125	0.275
Occupation, n (%)			0.146
Farmer	170 (68.0)	103 (77.4)	
Trader	43 (17.2)	17 (12.8)	
Others	37 (14.8)	13 (9.8)	
Education, n (%)			0.162
No formal education	86 (34.4)	56 (42.1)	
Elementary (primary or middle)	120 (48.0)	63 (47.4)	
Senior (secondary or higher)	16 (6.4)	3 (2.3)	
Other	28 (11.2)	11 (8.2)	
Ethnicity: n (%)			0.271
Ga-Dangme	235 (94.0)	121 (91.0)	
Other	15 (6.0)	12 (9.0)	

[a], Chi-square test
[b], Mann-Whitney U test

tional bed nets using insecticide tablets and explained the benefits of sleeping under treated bed nets and other malaria information. Volunteer residents had their conventional bed nets freshly treated or re-treated at no cost.

Surveys

Questionnaire-based interview

Pre- and post-intervention questionnaire-based interviews on malaria-related knowledge and practices were conducted with all study participants (186 children and 383 adults) from July to September, 2007, and April to June, 2008, respectively. Questionnaires were originally developed on the basis of previous studies investigating perceptions, knowledge and behaviours pertaining to malaria in Ghana and other countries [17-20]. The questionnaires were modified appropriately after pre-test was conducted with 22 mothers and 38 school children. There were two questionnaires: one for school children and one for community adults. Each of the questionnaires shared 14 question items pertaining to knowledge and five pertaining to practices. The questionnaire for adults contained three additional items pertaining to practices. For the post-intervention questionnaire interviews, three more question items were included to verify whether the community adults were exposed to the malaria education undertaken by the children. Native speakers of the Ga-Dangme language administered the questionnaire-based interviews. Before the administration of questionnaire, the interviewers were trained for a day by one of the authors (JKA) who is a native speaker of Ga-Dangme. Each of the participating children was interviewed at school. The adult participants were interviewed at home.

Observational survey

The research team made an observational survey on conditions in and around the households before the intervention in August, 2007. The observation with a simple check-list focused on possible mosquito breeding sites around the house, presence or absence of mosquito-proof netting on windows/trap doors and bed nets, and the condition of those mosquito prevention tools. As entering the house was perceived as an intrusion of privacy, the researchers asked an adult member of the households to bring one net, even though some of the households had multiple nets.

Parasitological survey

Finger-prick blood for preparation of thick and thin films on microscope glass slides was taken from the school children that volunteered in the intervention and control schools. The blood films were Giemsa-stained after fixing the thin film in methanol; they were then examined

Table 3: Comparison of changes in knowledge and practices among school children.

Knowledge/Practices	Knowledge: % of respondents who knew Practices: % of respondents who practiced very often or sometimes					
	Intervention (n = 105)			Control (n = 81)		
	Before (%)	After (%)	p-valuea	Before (%)	After (%)	p-valuea
Knowledge						
Meaning of ITN	80.4	90.5	0.039	88.9	81.5	0.185
Effectiveness of ITN against mosquitoes	96.3	95.8	1.000[b]	98.6	91.0	0.054[b]
Necessity of ITN re-treatment	30.5	55.2	0.001	36.1	37.9	0.830
Vulnerability of ITN to sunshine exposure	46.8	58.7	0.121	38.9	42.4	0.673
Place to get re-treatment service for ITN	69.5	92.6	<0.001	66.7	72.7	0.440
Paracetamol alone cannot cure malaria	34.0	69.5	<0.001	46.9	55.0	0.305
Breeding site of mosquitoes	42.2	74.3	<0.001	32.1	53.1	0.007
Habitat of mosquito larvae	94.3	95.2	1.000[b]	95.1	92.6	0.746[b]
Resting place for mosquitoes	91.4	93.3	0.603	93.8	95.1	1.000[b]
Mango cannot cause malaria	10.5	79.8	<0.001	18.5	4.9	0.013[b]
Heat from the sun cannot cause malaria	11.4	75.0	<0.001	6.3	6.3	1.000[b]
Mosquito bites can cause malaria	76.2	99.0	<0.001	90.1	90.1	1.000
Drinking dirty water cannot cause malaria	16.3	43.8	<0.001	8.6	8.6	1.000
Sex difference in biting behaviour of mosquitoes	15.2	24.8	0.084	5.0	5.0	1.000[b]
Practice						
Weeding around house in the past 6 months	90.5	90.5	1.000	85.2	80.2	0.406
Talking with family members about malaria in the past 6 months	55.2	43.3	0.084	17.5	7.6	0.060
Talking with neighbours about malaria in the past 6 months	51.4	37.5	0.043	22.2	4.9	0.002[b]
Burning something to prevent mosquitoes in the past 6 months	92.4	80.4	0.012	88.9	78.8	0.080
Covering arms and legs when going outside at night in the past 6 months	79.0	70.2	0.141	82.3	55.6	<0.001

[a], Chi-square test
[b], Fisher's Exact test

microscopically to detect malaria parasites. This exercise was performed pre-intervention in October 2007 and post-intervention in June 2008.

Data analysis

The sample size of 91 children in each group was calculated to detect statistical significance in differences in prevalence of malaria between pre- and post-intervention, with 80% power at 95% significance level. It was hypothesized that the initial prevalence would be 40%, and that a 20% decrease would be achieved in the intervention school.

Baseline differences in socio-demographic variables, conditions of malaria prevention tools, and possible mosquito breeding site were analysed by Chi-square test or Mann-Whitney U test. Differences between pre- and post-intervention in knowledge, practices, and parasite prevalence were analysed by Chi-square test or Fisher's Exact test. Statistical analysis was performed with SPSS 17.0 (SPSS Inc., Chicago, IL). A P value of < 0.05 was accepted as statistically significant.

Ethical clearance

Approval and ethical clearance for the study were obtained from the Scientific and Technical Committee

Table 4: Comparison of changes in knowledge and practices among community adults.

Knowledge/Practices	Knowledge: % of respondents who knew Practices: % of respondents who practiced very often or sometimes					
	Intervention (n = 250)			Control (n = 133)		
	Before (%)	After (%)	p-valuea	Before (%)	After (%)	p-valuea
Knowledge						
Meaning of ITN	86.3	74.6	0.006	93.1	89.1	0.266
Effectiveness of ITN against mosquitoes	84.7	93.2	0.006	86.9	84.7	0.635
Necessity of ITN re-treatment	51.4	52.1	0.891	59.5	33.6	<0.001
Vulnerability of ITN to sunshine exposure	54.9	75.1	<0.001	65.0	64.1	0.885
Place to get re-treatment service for ITN	62.5	72.4	0.032	63.6	65.0	0.832
Paracetamol alone cannot cure malaria	66.0	74.3	0.044	73.8	63.2	0.062
Breeding site of mosquitoes	57.4	66.7	0.034	65.4	51.1	0.018
Habitat of mosquito larvae	96.8	94.4	0.184	95.5	91.7	0.210
Resting place for mosquitoes	96.4	95.2	0.492	99.2	97.7	0.622[b]
Mango cannot cause malaria	15.6	61.1	<0.001	11.6	10.5	0.776
Heat from the sun cannot cause malaria	12.4	47.1	<0.001	4.6	2.3	0.334[b]
Mosquito bite can cause malaria	95.2	92.2	0.171	97.0	97.7	1.000[b]
Drinking dirty water cannot cause malaria	16.9	40.9	<0.001	3.0	2.3	1.000[b]
Sex difference in biting behaviour of mosquitoes	8.4	30.5	<0.001	0.8	3.0	0.370[b]
Practices						
Sleeping under bed net in the past 6 months	99.0	93.6	0.006[b]	92.9	94.9	0.525
Washing bed net in the past 6 months	95.7	93.6	0.391	91.3	95.3	0.280[b]
Treating bed net with insecticide in the past 6 months	21.5	50.0	<0.001	25.3	30.5	0.406
Weeding around house in the past 6 months	94.8	85.0	<0.001	94.7	83.1	0.003
Talking with children about malaria in the past 6 months	73.0	49.4	<0.001	40.6	34.8	0.334
Talking with neighbours about malaria in the past 6 months	43.4	33.1	<0.001	27.8	24.2	0.507
Burning something to prevent mosquitoes in the past 6 months	83.9	79.5	0.212	71.8	78.2	0.227
Covering arms and legs when going outside at night in the past 6 months	79.0	80.3	0.721	65.9	50.8	0.013

[a], Chi-square test
[b], Fisher's Exact test

and the Institutional Review Board, respectively, of the Noguchi Memorial Institute for Medical Research with the certified protocol number: CPN 038/06-07. Participants were informed that their participation was purely voluntary and assured of the confidentiality of all data collected. Informed written consent was obtained from adult participants, and parent/guardian of school children, with the children giving their assent. Verbal consent was obtained from participating children before conducting the survey.

Results

Study participants

From the total of 217 school children in the target grades, 186 participated both in the pre-and post-intervention questionnaire-based interviews and were used for analy-

Table 5: Results of household observational survey before the intervention.

Item/condition observed	Community households		
	Intervention (n = 172)	Control (n = 104)	p-valuea
Bed nets			
Possession of at least one net	149 (86.6%)	86 (82.7%)	0.558
Type of nets			
Long-lasting insecticide-treated nets	80 (53.7%)	49 (57.0%)	0.626
Conventional nets	69 (46.3%)	37 (43.0%)	
State of the nets			
Intact	114 (76.5%)	61 (70.9%)	0.618
Torn/hole	29 (19.5%)	21 (24.4%)	
Not in use	6 (4.0%)	4 (4.7%)	
Mosquito-proof nets on windows			
Furnished	36 (20.9%)	46 (44.2%)	<0.001
State of the nets			
Intact	25 (69.4%)	19 (41.3%)	0.011
Torn/hole	11 (30.6%)	27 (58.7%)	
Household compound			
Presence of trash container that can be breeding site of mosquitoes	83 (48.3%)	49 (47.1%)	0.722
Presence of covered water storage facility	134 (77.9%)	70 (67.3%)	0.028

[a], Chi-square test

sis. Participants consisted of 105 children (59 boys) out of a total of 128 in the intervention school, and 81 children (44 boys) out of a total of 89 in the control schools (Table 1). The median age was 13.0 (range: 8-20) years in the intervention school, and 12.0 (range: 8-21) in the control schools. No baseline difference was found between the intervention and control school children in age, sex, or distribution ratio by grade.

Of a total of 447 households, 383 were involved in the study and one participant from each household participated in the questionnaire-based interviews. Of the adult participants, 115 were caregivers of target children. Adult participants consisted of 250 adults (241 women) from the intervention village and 133 (125 women) from the control villages (Table 2). Median age was 35.0 (range: 16 to 93) years in the intervention village, and 35.5 (range: 18

Table 6: Prevalence of *P. falciparum* infection among target school children before and after intervention.

School children	P. falciparum prevalence (%)		p-valuea
	Pre-intervention	Post-intervention	
Intervention (n = 68)	30.9	10.3	0.003
Control (n = 63)	9.5	15.9	0.285

[a], Chi-square test

to 85) in the control villages. Most of the adults were engaged in farming (intervention village 68.0%, control villages 77.4%); over 90% were native Ga-Dangme speakers. Most of them had elementary or no formal education.

Questionnaire-based interview

According to the post-intervention interview, 23.1% (24/104) of the children in the intervention school responded that they had, at least once, presented a picture to family members and/or other community members. For adults in the intervention community, 37.1% (92/248) confirmed that a child showed a picture to them at least once; 80.7% (201/249) responded they had heard the "pumi song" sung by the school children; and 59.0% (147/249) responded that they attended the durbar at the intervention school.

School children in the intervention school significantly improved their knowledge on ITN, cause of malaria, mosquitoes, and paracetamol. Before the intervention, poor knowledge on cause of malaria according to response to question item was striking. After the intervention, those who correctly responded to the question items "Mango cannot cause malaria" increased from 10.5% to 79.8% ($p < 0.001$), from 11.4% to 75.0% on "Heat from the sun cannot cause malaria" ($p < 0.001$), and from 16.3% to 43.8% on "Drinking dirty water cannot cause malaria" ($p < 0.001$) (Table 3). Among school children in the control schools, the difference between pre- and post-intervention was only statistically significant in one item. In the practice questions, no positive change was found in the intervention group of children. Rather, "Talking with neighbours about malaria" and "Burning something to prevent malaria" decreased with statistical significance ($p = 0.043$, $p = 0.012$). In control school children, "Talking with neighbours about malaria" and "Covering arms and legs when going outside at night" also showed a statistically significant decrease ($p = 0.002$, $p < 0.001$).

As shown in children, adult participants' knowledge on ITN, cause of malaria, mosquitoes, and paracetamol also significantly changed in the intervention area. In most of the question items, the percentage of respondents who had correct knowledge was slightly higher in adult participants than in children before the intervention. However, adult participants who believed that mango, heat from the sun, or drinking dirty water can cause malaria accounted for more than 80%. This knowledge was significantly improved after the intervention (Table 4). In contrast, adult participants in the control area did not show an increase in any knowledge question items. In the practice section, the percentage of those who treated a bed net with insecticide in the past six months significantly increased from 21.5% to 50.0% in the intervention area ($p < 0.001$), although it was almost the same between pre- (25.3%) and post-intervention surveys (30.5%) in the control area. In the intervention area, the percentages significantly decreased in "Sleeping under bed net" ($p = 0.006$), "Weeding around house" ($p < 0.001$), "Talking with children about malaria ($p < 0.001$), and "Talking with neighbours about malaria" ($p < 0.001$). In the control area, the percentages also significantly decreased in "Weeding around house" ($p = 0.003$) and "Covering arms and legs when going outside at night" ($p = 0.013$).

Observational survey

One hundred and seventy-two out of 263 (65.4%) households in the intervention area and 104 out of 184 (56.4%) households in the control areas were observed. Most of the households (intervention area: 86.6%, control area: 82.7%) possessed at least one bed net (Table 5). Among the nets observed, nearly half (46.3%, 43.0%) were conventional nets. Most of the nets (76.5%, 70.9%) had no obvious holes or tears through which mosquitoes could invade. In nearly half of the households (48.3%, 47.1%), a dumped container, which could be a potential breeding site for mosquitoes, was found in the compound. Baseline differences were observed in the condition of mosquito proof nets and covers for water storage; fewer mosquito proof nets were furnished on the windows in intervention households (20.9%) than in control households (44.2%) ($p < 0.001$). In contrast, more mosquito proof nets were intact in the intervention households (69.4%) than in control households (41.3%) ($p = 0.011$). Water storages were more likely to be covered in the intervention households (77.9%) than in control households (67.3%) ($p = 0.028$).

Parasitological survey

Of the 105 children at the intervention school who participated in the questionnaire survey, 64.8% (68/105) participated in both pre- and post-intervention surveys; at the control schools, 77.8% (63/81) participated. In the intervention school, the median age (range) and male:female ratio were 14 (9-20) and 40:28, respectively, in the participating children; and 14 (8-18) and 19:18, respectively, in the non-participating children. In the control schools, the median age (range) and male:female ratio was 14 (10-19) and 29:34, respectively, in the participating children; and 15 (11-21) and 15:3, respectively, in the non-participating children. The difference in the male:female ratio between participating and non-participating children was statistically significant in the control schools ($p = 0.007$). *Plasmodium falciparum* was the only malaria parasite found among the school children. Parasite prevalence significantly reduced from 30.9% to 10.3% ($p = 0.003$) at post-intervention in the intervention school, while it increased from 9.5% to 15.9% in the control schools (Table 6).

Discussion

After the intervention, the malaria prevalence was significantly decreased in school children in the intervention school, although no decrease was observed in children in the control schools. Previous studies conducted in Ghana reported that falciparum prevalence was higher in the rainy season than in the dry season, and a little higher in the middle of the rainy season than at the beginning or end [21,22]. In the present study, pre- and post-intervention surveys were conducted at the end and middle of the rainy season, respectively. As is consistent with the trend reported from the previous studies, there was a slight increase in prevalence in the control schools at the post-intervention survey. Therefore, in the intervention school the effect of seasonal variation is unlikely to be the principal reason for the decrease. Although a marked difference in prevalence between intervention and control schools was observed at the baseline, intervention impacts can be considered as one of the main factors influencing prevalence reduction.

Previous studies conducted in sub-Saharan African countries including Ghana showed that people believed that not only mosquito bites, but also eating mango, drinking dirty water, and being exposed to hot sun were causes of malaria [17,19,20,23,24]. The same finding was observed in this study at pre-intervention. As Table 4 shows, 95.2% of the community adults correctly answered that mosquito bites can cause malaria. However, only a small proportion of the respondents disagreed with the incorrect statements that "heat from the sun", "eating mango", and "drinking dirty water" cause malaria. After the intervention, this knowledge was significantly improved in the intervention area. The improvement is important because a lack of understanding of the linkage between malaria and mosquito bites is associated with poor adherence to vector control interventions [20,25].

In this study, both community adults and school children showed significantly increased knowledge in the item "Paracetamol alone cannot cure malaria". In Ghana, most malaria cases have been managed at the household level [2]. However, during the fever episode, nearly 40% of children under 5 years old were not treated with any anti-malaria medicine [3], and in the absence of anti-malarials, paracetamol alone was commonly administered as treatment [18]. Knowledge improvement regarding treatment could be beneficial even to children. In Kenya, Geissler *et al* [26] reported that a considerable number of children self-treated their febrile illness without help from their caregivers.

In Ghana, most children under five years of age have yet to be protected by ITNs [3]. It has been emphasised that untreated conventional nets should be treated with insecticide to increase coverage of ITNs [3]. The observation survey found that 45% of the nets that respondents showed us were conventional nets. In response to the intervention, community adults who treated nets with insecticide increased from 21.5% to 50.0%, compared with the 25.3% to 30.5% in the control area. This fact suggests that the intervention was effective in increasing the coverage of ITNs.

Although the extra opportunity to treat their nets was provided to community people during the one-day campaign, providing an opportunity alone is unlikely to increase the net treatment rate. According to the local health authority, community people rarely participate in free net treatment services which health workers offer regularly in the study villages. Previous studies reported that barriers of insecticide-treatment were not only cost and access to treatment place, but also fear about insecticide, and poor linkage between malaria and ITNs [27-29]. Thus, community awareness raised by the children about the malaria likely had a substantial impact on increasing net treatment practices.

The results also showed that the frequencies of talking with children and guardians/neighbours about malaria unexpectedly decreased at the post-intervention survey. This trend was seen both in intervention and control groups. There is a possibility that community adults were busier at post-intervention period than pre-intervention period because of seasonally related changes to farming labour intensity. Unexpectedly, at the baseline, the frequency of talking between children and guardians/neighbours in intervention groups was much higher than those in control groups. This might be due to a higher burden of malaria, suggested by the higher prevalence at pre-intervention among school children in the intervention school.

This study has five major limitations. First, although conventional ITNs and long-lasting insecticide-treated nets (LLITNs) co-existed in the study site, no attempt was made to teach the respondents to recognize the two major differences to avoid confusion which might arise among study participants; conventional ITNs should be regularly treated and not be washed frequently. In contrast, LLITNs have no need of treatment until nets are washed many times and should be washed to activate insecticide agents. This limitation might be reflected in the result showing that knowledge "Necessity of ITN re-treatment" was not improved in the intervention area. Additionally, almost all of the community respondents reported that they washed their nets "very often" or "sometimes" in the past six months, although some of the nets must have been conventional ITNs. Second, although we used the local word "Asra" to define malaria, "Asra" does not necessarily correspond to "malaria" as defined by modern medicine. As shown in the previous study in Ghana, "Asra" was used interchangeably to define both malaria and fever [19]. Third, in data analysis, clus-

tering of individuals within the same school was not taken into account, resulting in failure in addressing the cluster effects including class differences within the school. Fourth, results of the parasitological survey might be biased because of selection bias. Although no age and sex difference was observed between children who participated in the survey and those who did not, sex difference was observed in the children in the control schools. Finally, a randomised controlled design was not employed. However, no baseline difference was observed in demographic characteristics of the study participants and bed net related characteristics.

For the intervention, schoolteachers successfully adopted education activities using the PLA approach, such as role-playing, poetry recitals, slogan chanting, song composition and dramatization. These activities could be socially and culturally acceptable, because teachers themselves designed these activities. The results showed that most of the community adults were exposed to these activities. Moreover, participants in the intervention area were more likely to talk about malaria than those in the control area. Thus, the application of this strategy in other malaria endemic areas is recommended.

Scaling up school-based health education interventions should be easy if a well-established school health system is available. The study in Thailand utilized a school health system based on the Health Promoting School concept [14]. In recent years, WACIPAC has introduced the strategy for the setting up and establishment of school health management systems as a national programme in 10 West African countries. Moreover, WACIPAC has recommended the necessity of coordination among donors interested in school health. Partnership has been promoted between governments in target countries and donors for the establishment of school health management systems. Thus, school-based intervention has the potential to be scaled up on the basis of the systems in each country in West Africa.

Conclusions

School-based malaria education intervention engaging school children as health messengers had a substantial impact not only on school children, but also on community adults in improving knowledge on cause and prevention and bed net impregnation practices. The improved knowledge and practices could be associated with the decrease in the malaria prevalence observed in the school children.

Additional material

Additional file 1 Appendix: Teacher training programme. The appendix shows detailed contents of the teacher training and teaching aids used in the training.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

IA and DN were the principal investigators and responsible for the whole process. JKA coordinated field implementation and contributed to the data collection. SH and JK contributed to field implementation, data analysis and manuscript drafting. MJ, TM, and TT contributed to reviewing the manuscript. KMB and DAB were involved in protocol development and contributed to study design development. All authors read and approved the final manuscript.

Acknowledgements

The authors would like to sincerely acknowledge Prof. Alexander K. Nyarko, Director of the Noguchi Memorial Institute for Medical Research and the WACIPAC Project, the Ghanaian staff, and the JICA experts on the WACIPAC project for their interest and contributions to the study. This project was funded by the Ministry of Health, Labour and Welfare of Japan (Kosei Kagaku Research Grant, International Cooperation Research Grant 21S3).

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Received: 8 January 2010 Accepted: 18 April 2010
Published: 18 April 2010

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doi: 10.1186/1475-2875-9-98
Cite this article as: Ayi *et al.*, School-based participatory health education for malaria control in Ghana: engaging children as health messengers *Malaria Journal* 2010, **9**:98

Acta Tropica 112 (2009) 283–287

Contents lists available at ScienceDirect

Acta Tropica

journal homepage: www.elsevier.com/locate/actatropica

Public and private sector treatment of malaria in Lao PDR

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ARTICLE INFO

Article history:
Received 25 September 2008
Received in revised form 9 August 2009
Accepted 10 August 2009
Available online 14 August 2009

Keywords:
Malaria
Health care seeking behavior
Artemisinin-based combination therapy
Laos

ABSTRACT

This study aimed to examine the care-seeking choices for treatment of a febrile illness compatible with malaria in the public and private sectors in Lao PDR. We conducted interviews with 745 heads of household in 14 villages in the Sekong province, using a structured-questionnaire. We asked each about who the care-providers were for febrile illness episodes affecting their household members during the past year. If patients used more than one care-provider for a single episode over a period of time, we identified patterns of the care-sequences for the initial and subsequent care choices. Then, we analyzed the relationship between the initial care choices and secondary care choices for care-providers by Chi-square test, categorizing care-providers into public (hospital, health centre, and village health volunteer) and private care-providers (private pharmacy, informal retailer, faith healing and herbs). As a result, we found that 624 patients sought care at least once, 255 (40.9%) twice, and 66 (10.6%) three times or more during a single episode. Of 138 patients who started with a public care-provider and then sought a secondary care, 71 (51.4%) switched to a private care-provider. In contrast, of 117 patients who started with a private care-provider and then sought a secondary care, 82 (70.1%) switched to a public care-provider ($p < 0.001$). In conclusion, although most patients who failed being treated by a private care-provider switched to a public one, some exclusively relied on care within the private sector. An intervention is necessary to make the private sector an integral component of malaria treatment in Lao PDR.

1. Introduction

Improving access to effective malaria treatment has become one of the greatest challenges due to a widespread resistance of parasites to anti-malaria medicines. In recent years, artemisinin-based combination therapy (ACT) has been adopted as a first-line treatment for uncomplicated malaria in many countries including Lao PDR (WHO and UNICEF, 2005). Researchers are increasingly recognizing that studies of care-seeking behaviors contribute to assessing patients' access to ACT and developing effective intervention strategies for malaria control (WHO, 2005a).

In sub-Saharan Africa, where 90% of the estimated malaria-attributable deaths in the world occur, a considerable number of studies have been carried out to examine the care-seeking behaviors for malaria treatment. These studies were reviewed and the authors found that patients often use multiple sources of care for a single illness episode, especially when treatments result in failure (McCombie, 1996, 2002; Williams and Jones, 2004). The first response to febrile illness or uncomplicated malaria is generally some type of home treatment with modern medicines, herbal medicines, and/or other more traditional means; if necessary, people subsequently seek care from health care facilities (Kengeya-Kayondo et al., 1994; Théra et al., 2000; Baume et al., 2000; Nyamongo, 2002).

Medicines were often purchased from the private shops because such providers were closer than the nearest health facility and had a reliable supply of medicines (Goel et al., 1996; Molyneux et al., 1999; McCombie, 2002). Traditional healers were more likely to be involved in treatment if convulsions appeared (Baume et al., 2000; Molyneux et al., 2002; Makundi et al., 2006). Reasons for not seeking care from the health care facilities as the first choice included difficult access, expensive treatment fee, lack of medicines and equipment, and poor staff attitudes. However, once signs of serious illness were recognized or symptoms persisted, help was mostly sought from the health care facilities (Ndyomugyenyi et al.,

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0001-706X/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.actatropica.2009.08.013

1998; Nyamongo, 1999; Baume et al., 2000; Geissler et al., 2000; Théra et al., 2000; Nyamongo, 2002).

Lao PDR is located in the Southeast Asia, sharing international borders with Thailand, Vietnam, Cambodia, China (Yunnan Province) and Myanmar. In a group of these six countries, the Mekong Roll Back Malaria Initiative has been launched since 1998 to establish close cooperation between countries (WHO, 2001). Care-seeking patterns differ from country to country even in the region. For example, the first resort to care for uncomplicated malaria was mostly the public health care facilities in Vietnam (Giao et al., 2005), while common source of initial treatment for a febrile illness was a local village vendor in Cambodia (Yeung et al., 2008). However, little has been reported about the care-seeking behaviors for malaria treatment in Lao PDR.

Malaria is the leading cause of morbidity and mortality in Lao PDR, with 70% of population at risk. The annual incidence in 2006 was 432 cases per 100,000 people. Other major causes of febrile illness were dengue fever and typhoid fever, with the incidence of 97 and 33 cases per 100,000 people, respectively (WHO, 2009). Little information is available on epidemiological trends about chikungunya fever.

In Lao PDR, the public health sector is distinct from the private one, in particular, in rural settings. In the public sector, health care providers are staff in hospitals and health centres as well as village health volunteers (VHVs). In each village, two or three VHVs are present to assist primary health care activities. Particularly in villages where people have difficulty in accessing a hospital or health centre, district health officers train the VHVs for approximately three weeks to enable them to appropriately administrate an essential medicine kit including anti-malaria medicines (Rattanaxay et al., 2005). In the private sector, health care providers are staff in the clinics and licensed pharmacies, informal retailers and traditional healers. Although public health care providers respond to malaria in accordance with the National Malaria Control Policy, private providers do not need to follow the government policy and treatment guideline.

A 2001 National Health Survey showed that nearly 40% of patients who were suffering from a fever with malaria-like symptoms managed their illness outside of health care facilities of the public sector (Ministry of Health, 2001). Additionally, ACT using artemether-lumefantrine has been the first-line treatment for uncomplicated malaria since 2005 and is currently available throughout the country; however, its availability is limited only to the public sector, except a limited number of private licensed pharmacies involved in a pilot project which has been implemented since 2008 to assess the possibility of dealing with ACT. Thus, we need to pay greater attention to the series of patients' and their caretakers' choices of care-providers for malaria treatment. Thus, in this study, we aimed to conduct synchronic and diachronic analyses of care-seeking choices for treatment of a febrile illness compatible with malaria in the public and private sectors in Lao PDR. In this paper, we defined "synchronic analysis" as analysis indicating frequencies of use of care-sources at a particular point in time and "diachronic analysis" as analysis indicating sequences of use of care-sources over a period of time. These terms were similarly used by Baume et al. (2000).

2. Materials and methods

2.1. Study sites

We carried out this study in the Lamarm district of the Sekong province, in the southern region of the country, between November 2005 and January 2006. The population of the district was approximately 27,000 in 2005. According to passive case detection at public health care facilities, the annual incidence of malaria in 2003 was 15.4 cases per 1000 people in the Sekong province, the highest in the country (WHO and UNICEF, 2005), and *P. falciparum* accounted for more than 95% of the reported cases (Rattanaxay et al., 2005).

Governmental health care facilities in the district include the Sekong Provincial Hospital, and four health centres, but no district hospital. Nor does the district have any private hospitals or clinics. However, 13 private pharmacies exist, selling anti-malaria medicines without a prescription. These private pharmacies are concentrated at a market in the district centre.

For this study, we selected 14 out of 66 villages in the district. First, we selected five villages out of 36 villages from the catchment area of the Sekong Provincial Hospital; malaria has been shown to be endemic in three of these villages but not the remaining two villages. Second, we included all the 12 villages from the catchment areas of the two health centres that are located in more remote areas than the other two health centres in the district. However, we excluded three villages in which interviews were difficult to conduct; two villages had households scattered across a wide area and one village had many migrant workers.

2.2. Target population

Lao accounted for the majority of the population in the Lamarm district centre around the Sekong Provincial Hospital, whereas Alak, Taliang and Lavie ethnic groups dominated outside the district centre. These ethnic groups are predominantly subsistence farmers.

The number of households and population in the selected villages was 864 and 4238, respectively. Most of the population belongs to Alak or Lavie. We invited each head of household, or the next responsible person (e.g. a spouse) if the head of household could not participate, to take part in interviews, and 745 (86.2%) people participated. We excluded the data of two households due to missing data in their questionnaires. Overall, we analyzed data of 743 households to examine the responsible members' care-seeking behaviors.

We also invited the total population to participate in blood examinations to identify the prevalence of malaria among the population, and of the total population, 3264 (76.2%) participated.

2.3. Data collection

Our data collection consisted of interviews with heads of household and blood examinations of the villagers.

First, two trained health personnel conducted interviews with heads of household at each target village, using a pre-tested, structured-questionnaire. The interviews took place one-on-one at a VHV's house, and the interviewers used Lao language and employed the special local term "*khai-nyung*" (mosquito fever) to define malaria. We asked each interviewee whether they had a household member who suffered from "mosquito fever" or other febrile illness compatible with malaria during the past year. If they had, we further asked each interviewee who the care-providers for the episode were. In the case where a household had multiple episodes, we asked the interviewee to adopt a perceived severe episode. If the patient's initial care in response to the first response was not successful and subsequent care was sought, we asked the interviewee about who the care-providers for subsequent care were, and we recorded data for up to three attempts of seeking care for a single episode.

Second, we conducted blood examinations to identify the prevalence of *P. falciparum* among villagers living in the target villages. We collected samples from participants who were willing to participate in the examination or from young children whose guardians allowed them to participate. We invited participants to congregate at a designated place such as a village assembly hall, school,

Table 1
Synchronic analysis of sources of care in the initial, secondary and tertiary care.

Sources	Total		Initial care		Secondary care		Tertiary care	
	n	(%)	*n*	(%)	*n*	(%)	*n*	(%)
VHVs	149	15.8	97	15.5	50	19.6	2	3.0
Hospital	177	18.7	148	23.7	17	6.7	12	18.2
Health centre	250	26.5	148	23.7	82	32.2	20	30.3
Private pharmacy	172	18.2	103	16.5	51	20.0	18	27.3
Informal retailer	30	3.2	22	3.5	8	3.1	0	0.0
Faith healing	142	15.0	94	15.1	40	15.7	8	12.1
Herbal remedy	25	2.6	12	1.9	7	2.7	6	9.1
Total	945	100.0	624	100.0	255	100.0	66	100.0

Table 2
Diachronic analysis of sequences in which patients or their caretakers sought the initial to secondary care.

Initial care		Secondary care							
				Sources					
			Public			Private			
Sources	No. of people who sought care	No. of people who sought care (%)	VHVs	Hospital	Health centre	Private pharmacy	Informal retailer	Faith healing	Herbal
VHVs	97	48 (49.5)	4	3	22	12	0	6	1
Hospital	148	26 (17.6)	3	4	1	16	0	1	1
Health centre	148	64 (43.2)	4	4	22	9	6	19	0
Private pharmacy	103	27 (26.2)	3	3	5	3	1	9	3
Informal retailer	22	10 (43.5)	0	1	3	2	0	4	0
Faith healing	94	72 (76.6)	32	2	28	6	1	1	2
Herbal remedy	12	8 (66.7)	4	0	1	3	0	0	0
Total	624	255 (40.9)	50	17	82	51	8	40	7

or health centre; the place differed from village to village. Two laboratory technicians collected a finger prick blood sample from the participants for testing with a rapid immuno-chromatographic test, Paracheck Pf® (Orchid Biomedical Laboratories, Goa). Medical doctors treated the participants who tested positive, following the National Malaria Treatment Guidelines.

2.4. Data analysis

After consulting with Lao health workers, we categorized the care-providers as follows: (1) hospital, (2) health centre, (3) VHVs, (4) private pharmacy (retailer with sales license), (5) informal retailer (retailer without sales license), (6) herbal remedy, and (7) faith healing with or without a professional healer. Each category includes the visit to these providers and the use of leftover medicines previously obtained from these providers.

In the beginning, we conducted synchronic analysis of the care-seeking choices in the initial, secondary and tertiary care. We then conducted diachronic analysis over the initial and secondary care. We also analyzed the relationship between the initial care choices and secondary care choices of care-providers by Chi-square test, categorizing their care-providers into public (hospital, health centre, and VHV) and private care-providers (private pharmacy, informal retailer, faith healing, and herbal remedy). For the analysis, we used SPSS 12.0 statistical software (SPSS Inc., Chicago, IL), with a p-value of <0.05 accepted as statistically significant.

2.5. Ethical clearance

This study was approved by the National Ethics Committee for Health Research, Ministry of Health, Lao PDR (no. 044/NECHR). We made sure the participants knew their participation would be voluntary and that all data obtained would be confidential, and obtained verbal and written consent from all the participants before conducting the survey.

3. Results

The mean age (SD) of the 743 interviewees was 38.1 (15.2), with a range of 15 to 90. Of the interviewees, 665 (89.4%) were men. Six thousand and twenty-four interviewees (87.9%) mentioned that at least one of their household members suffered from a febrile illness compatible with malaria during the last one year and sought any form of care. Of 624 patients, who sought at least once, 255 (40.9%) had sought care at least twice and 66 (10.6%) had sought care thrice or more as time passed.

Table 1 shows the synchronic analysis that describes care from each source at the initial, secondary and tertiary care. Health centre was most frequently used throughout all attempts to seek care, accounting for 23.7% at the initial, 32.2% at the secondary, and 30.3% at the tertiary care. During the initial care, the major source of care other than health centre was hospital (23.7%), followed by private pharmacy (16.5%), and VHVs (15.5%). In the secondary care, the proportion of private pharmacy and VHVs slightly increased to 20.0% and 19.6%, respectively, while the use of hospital sharply decreased to 6.7%. Throughout all attempts, proportion of faith healing made a little change, ranging from 12.1% to 15.7%. The use of informal retailer and herb occupied only a small proportion.

Table 2 shows the diachronic analysis of sequences in which patients or their caretakers sought the initial and secondary care. Among those who sought care once, 40.9% subsequently sought care; the maximum percentage seeking secondary care was faith healing at 76.6% and the minimum was hospital users at 17.6%. The sequences frequently found were: (1) faith healing followed by VHVs (32) or health centre (28); (2) VHVs followed by health centre (22) or private pharmacy (12); (3) health centre followed by health centre again (22) or faith healing (19); (4) hospital followed by private pharmacy (16); and (5) private pharmacy followed by faith healing (9). These patterns covered more than a half of reported sequences between the initial and secondary care.

Table 3
Cross-tabulation of a change in the care-sources from the initial to secondary care.

		Secondary care sources		p-value
		Public (%)	Private (%)	
Initial care sources	Public	67 (48.6)	71 (51.4)	<0.001
	Private	82 (70.1)	35 (29.9)	

Table 3 shows a cross-tabulation of a change in care-providers from the initial to secondary care. Among 138 patients who sought initial care from a public provider and then sought secondary care, 67 (48.6%) sought secondary care from a public provider. The remaining 71 (51.4%) changed to a private provider. In contrast, among 117 patients who sought initial care from a private provider and then sought secondary care, 82 (70.1%) switched to a public provider for secondary care. The remaining 35 (29.9%) repeatedly used a private provider. These differences in the provider choices was statistically significant ($p < 0.001$).

Table 4 shows the prevalence of *falciparum* malaria in the target villages. In total, the mean prevalence was 13.7% (447/3260). The prevalence was the higher in children aged 5–14 years (23.2%) than in other groups; children under-five (15.2%) and adult participants (7.2%).

4. Discussion

The primary finding of this study is that approximately one third of the patients who failed treatment with a private care-provider subsequently sought care from a private care-provider.

This finding suggests that the public sector should collaborate with the private sector to ensure a patient's access to ACT at the early stages of his or her care-seeking. In fact, access to appropriate and effective treatment for malaria should be provided within 24 h of the onset of symptoms (WHO, 2005b). However, chroloquine, which is most likely to be prescribed by private retailers, has lost its clinical effectiveness in some parts of the country due to resistance (Mayxay et al., 2003; Schwöbel et al., 2003). Moreover, counterfeit anti-malaria medicines widely spread among private retailers in the country (Newton et al., 2001; Dondorp et al., 2004).

In response to the increased recognition of the role of private care-providers in countries other than Lao PDR, health professionals have made efforts to make private retailers an integral component of malaria treatment. For example, a social marketing of rapid diagnosis kit and ACT has been encouraged throughout the private retailers in Cambodia (Yeung et al., 2008), and a referral system from traditional healers to public care-providers has been established in Tanzania (Makundi et al., 2006). Our results suggest that interventions among private pharmacies and faith healers could be one option to cover such a wide variety of the series of care-seeking choices seen in our study.

As Table 2 shows, among the patients who sought care from faith healing as the first choice, most of them (86.1%) switched to a public care-provider for a secondary treatment. Such transitioning from traditional care to modern care was consistent with the findings of the studies in Tanzania, Mali, and Burkina Faso (Hausmann-Muela et al., 1998; Théra et al., 2000; Beiersmann et al., 2007). Additionally, previous studies conducted in Lao PDR emphasized the importance of education programs for those who have the indigenous belief that ill health can be caused by an evil spirit and cured by traditional faith healing practices (Shirayama et al., 2006; Nonaka et al., 2008). Our results, however, provided evidence that people recognized the value of modern care; traditional care and modern care were not mutually exclusive in our study.

As Table 3 shows, among the patients who sought initial care from a public care-provider and then needed subsequent care, nearly a half of them switched to a private care-provider for their secondary care. This result suggests that strengthening the follow-up and referral system can be one of the challenges with care within the public sector. In Kenya and Ethiopia, people frequently visited private hospital or clinic in cases where the public care-provider failed in treatment (Mwabu, 1986; Deressa et al., 2008). In Lao PDR, such private health care facilities are available only in very limited areas, suggesting that the role of public care-providers is more important.

The results also show that, even after receiving care from a public care-provider, a significant proportion of patients required subsequent care. We particularly consider two factors possibly influencing this: first, there is a possibility that re-infections of malaria could occur in the patients between the initial and secondary care; second, care-seeking episodes reported here occurred before and during the change of the first-line medicine from chloroquine to artemether-lumefantrine.

In this study, we also examined the prevalence of malaria at each target village. The results show that malaria was prevalent among children in the target villages. Although we did not link the results of care-seeking pattern analysis, the results could provide important background information on the target communities. Identifying endemicity of malaria is important because the level of endemicity is one of the factors influencing care-seeking behavior (McCombie, 1996).

Many previous studies of treatment-seeking did not describe how malaria was defined to identify appropriate local disease categories for an interview (McCombie, 2002). We used the Lao word "*khai-nyung*" that means mosquito fever in the interview. Although we made no attempt to identify the validity of such word, the results suggest that the word might reflect "malaria" defined by modern medicine.

However, this study does have three major limitations. First, we should take into account the bias of the one-year recall period. To minimize the recall bias, we focused on perceived severe episodes if the households had multiple episodes. Yet, previous studies also employed a one-year recall period to investigate care-seeking behaviors for malaria (Molyneux et al., 2002; Bell et al., 2005). Second, we did not measure the duration between care events for a single episode. A similar study conducted in Kenya reported that a mean of 0.6 (SD 0.8) days elapsed between the onset of illness and the initial treatment step, and 2.9 (SD 2.8) days between the second and third steps (Mwabu, 1986). Finally, because we employed febrile illness episodes, some or many of episodes reported from participants may not correspond to a clinical case definition of malaria. However, our blood test results do show that malaria was prevalent in the studied villages.

In conclusion, most of the patients involved public care-providers in treatment of their episodes, either as primary or secondary care. However, some remained outside the public health care system during the sequence of their care-seeking. Additionally, the use of a public care-provider as the first choice did not necessarily predict that patients would seek care from a public care-provider in the instance that secondary care was sought. Therefore, an intervention is necessary to improve access to effective treatment at an early stage of care-seeking in collaboration with the private sector as well as to strengthen follow-up and referral systems within the public sector for malaria treatment in Lao PDR.

Table 4
Prevalence of *falciparum* malaria in the target villages.

Age categories	Positive	Negative	Prevalence (%)
<5	97	541	15.2
5–14	234	773	23.2
>15	116	1499	7.2
Total	447	2813	13.7

Acknowledgments

The authors gratefully acknowledge support from the Lamarm District Health Office and Sekong Provincial Health Office. We would like to thank the field study members, village leaders, and study participants for their cooperation. This study was supported by a Grant for International Health Cooperation Research (17C-5, 19C-1) from the Ministry of Health, Labour and Welfare of Japan.

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