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Promoting community knowledge and action for malaria control in rural Cambodia: potential contributions of Village Malaria Workers

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Abstract

Background: Cambodia has been investing in Village Malaria Workers (VMWs) to improve malaria case management in rural areas. This study assessed the quality of the VMWs' services compared to those by a government-run health center from the perspective of community members. We focused on VMWs' contribution to promote their action to control malaria. A community-based cross-sectional study was conducted in Kampot province in 2009. Interviews were conducted at every accessible household in a village with VMWs (n = 153) and a village with a health center (n = 159), using interviewer administered questionnaire. Preference of the interview was given to female household head. Multiple regression analyses were run to compare knowledge about malaria, preventive measures taken, and time before first malaria treatment between the two villages.

Findings: The villagers perceived the VMWs' services equally as good as those provided by the health center. After controlling for confounding factors, the following indicators did not show any statistical significance between two villages: community members' knowledge about malaria transmission (AOR = 0.60, 95% CI = 0.30-1.22) and government-recommended antimalarial (AOR = 0.55, 95% CI = 0.25-1.23), preventive measures taken (Beta = −0.191, p = 0.315), and time before the first treatment (Beta = 0.053, p = 0.721). However, knowledge about malaria symptoms was significantly lower in the village with VMWs than the village with a health center (AOR = 0.40, 95% CI = 0.19-0.83).

Conclusions: VMWs played an equivalent role as the health center in promoting malaria knowledge, action, and effective case management. Although VMWs need to enhance community knowledge about malaria symptoms, the current government policy on VMWs is reasonable and should be expanded to other malaria endemic villages.

Keywords: Malaria, Village Malaria Workers, Treatment-seeking behavior, Knowledge, Preventive measures, Symptoms, Antimalarial drug, Community, Cambodia, Public health

Findings

Background

Malaria continues to be a leading cause of morbidity and mortality worldwide, although the disease is preventable and treatable [1]. World Malaria Report 2011 estimated 216 million clinical cases and 655 000 malaria deaths worldwide in 2010 [1]. According to the most systematic assessment of mortality done by Murray CJ and colleagues, global malaria deaths was 1.24 million in 2010, which was almost double compared to World Malaria Report's estimate [2]. Their estimate implies that malaria may impose even greater burden on populations living in endemic areas.

Globally, early diagnosis and prompt treatment with effective antimalarial drug are the cornerstones of current malaria control policy [1]. The success of this strategy at community-level depends on early recognition of the symptoms and the subsequent treatment-seeking behavior [3]. Many studies have found numerous factors associated with treatment-seeking behavior for malaria. They include affordability of treatment, availability and effectiveness of drugs, geographic accessibility, and perception of severity of the illness, quality of care and cultural

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beliefs about the cause [4]. Many of these factors are specific to the local context. An effective malaria control strategy, thus, requires accurate information on local perceptions and practices regarding malaria [5].

In many malaria-endemic countries, however, key challenges have been the lack of human capacity and health systems for delivering essential interventions [6]. The potential contribution of community health workers (CHWs) has renewed interest in overcoming these challenges, since they act as the first line of contact with the health system in most resource-poor countries [7]. A recent study from Zambia demonstrated that CHWs were able to manage malaria related fevers by correctly interpreting Rapid Diagnostic Test (RDT) results and appropriately prescribing antimalarials with parasitological confirmation [8]. Evidence from Ghana showed CHWs achieved higher coverage and adherence of intermittent preventive treatment of malaria in children [9].

In Cambodia, malaria continues to be a major public health problem. Over 6 million people are living in high transmission area [1]. Malaria incidence is particularly high in remote and resource-poor villages without public health services. The specific high-risk groups are pregnant women and children living in heavily forested villages, and forestry workers who have recently migrated from non-endemic areas [10]. In 2010, Cambodia had 49,356 probable and confirmed malaria cases and 151 malaria attributed deaths. *Plasmodium falciparum* accounted for 66% of confirmed malaria cases [1].

To improve malaria case management in remote forested areas, Cambodia has undertaken the Village Malaria Worker (VMW) project as part of its national malaria control program. The VMW project started in Rattanakiri province in northeastern Cambodia in 2001. A further pilot project was implemented in Koh Kong province in 2002. Based on the success of these pilot efforts, the VMW project was scaled up to cover 300 villages in seven provinces in 2004, with financial support from the Global Fund to Fight AIDs, Tuberculosis and Malaria. It has since been further scaled up to 1528 villages in 17 provinces (Cambodia National Malaria Center, Ministry of Health of the Kingdom of Cambodia, unpublished observations).

VMWs received two days of training under supervision of Cambodia National Malaria Center. Through the training, they learn cause, symptoms of malaria, and how to perform RDTs (*Plasmodium falciparum* only) on villagers suspected of having malaria and provide treatment according to national guidelines. The curriculum also includes identifying danger signs, and referring severe cases to the nearest health center, as well as recording and reporting the number of RDTs performed, malaria cases detected, and antimalarial used [11]. VMWs render services in their homes for free of charge. HC staff members have three years of nursing school training in providing basic treatment for a wide variety of diseases.

A previous study evaluated the nature and quality of the VMWs' services by interviewing VMWs [12]. However, few studies have identified the similarities and differences between the quality of the VMWs' services and those by a government-run health center from the perspective of community members.

This study, therefore, aimed at comparing the quality of services in promoting accurate knowledge about malaria, antimalarial, effective malaria control measures, and appropriate treatment-seeking behavior between a village with VMWs and a village with a health center. This study will provide important information for devising strategies to improve access to prompt and effective malaria treatment in underserved rural areas.

Methods

Study design and study area

A community-based cross-sectional study was conducted in Kampot province. The Province is one of the malaria-endemic areas in rural Cambodia. It is located about 150 km south of the capital, Phnom Penh, and had an estimated population of 620,000 in 2008 (Cambodia National Malaria Center, Ministry of Health of the Kingdom of Cambodia, unpublished observations). The province has 522 villages and four operational district hospitals (ODHs) and 49 health centers (HCs) (Cambodia National Malaria Center, Ministry of Health of the Kingdom of Cambodia, unpublished observations). Malaria is endemic in 133 villages of the villages. Of these villages, 27 have VMWs, who have been trained to perform rapid diagnostic tests on villagers suspected of having malaria and provide treatment according to national guidelines, and 84 have village health volunteers (VHVs), who have been trained to provide malaria-related health education in their communities. Most malaria transmission takes place during or shortly after the rainy season, with the peak between July and September.

Of 133 malaria endemic villages, we purposively selected one VMW village and one HC village based on similar characteristics of malaria incidence and population. A VMW village was defined as a village without a health center where VMWs are serving. On the other hand, a HC village was defined as a village where a health center is located but VMWs are not serving. Andeng Sang, the VMW village, and Srakak Neak, the HC village are 10 km apart. The VMW project was implemented in Andeng Sang in 2005. As is the case with other VMW villages, two VMWs were serving in the village. The Koh Slah Health Center in Srakak Neak is staffed by five nurses and four midwives; it is also the nearest health center to Andeng Sang. According to a

2008 survey by Cambodia's National Malaria Center (CNM), Andeng Sang had 606 inhabitants and 55 reported malaria-positive cases and Srakak Neak had 651 inhabitants and 55 reported malaria-positive cases.

Selection of study participants

We visited every accessible household (Andeng Sang: 153/165 households; Srakak Neak: 159/166 households) and screened members for inclusion in interviews. Twelve households in the VMW village and seven households in the HC village could not be reached due to fear of unexploded landmines or geographic inaccessibility. In each household, preference for the interview was given to the primary caregiver, usually the female head of the household. In her absence, the male head of the household was interviewed. If neither was present, a responsible adult above the age of 18 (e.g. mother/father/daughter/son of female/male household head), who understood family medical history and treatment-seeking behavior as well as care givers, was interviewed. Only one person per household was interviewed.

Data collection

We collected data in August, 2009, during the peak malaria transmission season. An interviewer administered questionnaire was used to collect data after conducting pre-tests. Household interviews were conducted by eight trained field workers who spoke the local language, Khmer, and were fully familiar with the local culture and sensitivities. The questionnaire had been translated from English into Khmer, and the respondents' answers were translated into English. Questionnaire administration was monitored daily for quality control.

The questionnaire addressed the following topics:

(1) Socio-demographic characteristics of the respondent and his or her family.
(2) Knowledge about malaria (its transmission route and symptoms, name of government-recommended antimalarial drug).
(3) Actions taken to prevent malaria (personal preventive measures and mosquito control measures).
(4) Treatment-seeking behavior for malaria (history of fever and malaria infection, symptoms that prompted patients to seek care outside the home, type and number of treatment sources consulted, reason for choosing the first provider, time from symptom onset to receiving the first treatment, type of diagnosis, and form of therapy given).

Measures

Knowledge about malaria was measured in three parts: malaria transmission, malaria symptoms, and government-recommended antimalarial. Regarding transmission, respondents who answered that mosquito bites were the only route for transmission were given one point. Those who gave another cause or a number of causes in addition to mosquito bites were given zero points. Regarding malaria symptoms, this study defined fever, shivering, and sweating as the three major malaria symptoms. Respondents who named all three major symptoms were given one point. Those who gave other malaria symptoms in addition to the three major symptoms were also given one point. Those who couldn't name all of three major symptoms were given zero points. Regarding government-recommended antimalarial, A + M was the first line antimalarial drug for uncomplicated malaria recommended by Cambodian government. Although Malarine was a commercialized antimalarial, it contains the same drug component as A + M. Thus, we also assumed Malarine as the recommended first line antimalarial drug. Those who gave correct name of A + M or Malarine were given one point. Those who gave the name of drug other than the above two were given zero point.

The number of personal preventive measures and mosquito control measures taken were calculated. Respondents who had taken personal measures with potential preventive effects (use of a treated mosquito net, wearing long sleeves and trousers, burning cow dung/leaves, using mosquito coils, using repellents, and closing windows and doors) were given one point. Respondents were given one point for each mosquito control measure taken (draining stagnant water and keeping the compound clean and/or building latrines to reduce mosquito breeding/resting places), regardless of the frequency. Total scores ranged from 0 to 9. Scores for the time between the onset of symptoms and the first malaria treatment were: same day = 0, next day = 1, two days after onset = 2, three or more days after onset = 3.

Data analysis

Statistical analyses were performed using STATA version 11. The student *t*-test was used to compare age and number of household members in the VMW village and the HC village. Differences in proportions were compared for significance using the Chi-square test or Fisher's exact test. To run multiple regression analyses, we assessed multicollinearity between 12 potential confounders. We assumed that multicollinearity exists when correlation coefficient was above 0.50. As a result, we excluded 3 variables which had collinearity with other variables. They were the nearest health facility, place of blood test and the number of children under 18 years. We selected the variables which seemed to have bigger impact on community knowledge, actions and treatment seeking behavior. We also included variables which were

not statistically significant in bivariate analyses, but were found to be determinants of treatment-seeking behavior and malaria-related knowledge in the previous studies. We included them because insignificant variables in bivariate analysis may become significant in multivariate analysis. We finally included 9 potential confounders in the regression models. They were age, gender, marital status, highest level of education, occupation, number of household member, monthly income, first treatment source for malaria-like symptoms, and distance from health facility. Primary outcome variables in the multiple regression analyses were (1) knowledge about the cause of malaria, (2) knowledge about malaria symptoms, (3) knowledge about government-recommended antimalarial for uncomplicated malaria, (4) preventive and control measures taken, and (5) time before first malaria treatment. A p-value of <0.05 was considered statistically significant.

Ethical considerations

Ethical approval was obtained from the Cambodian Ministry of Health and the Ethical Committee of the Faculty of Medicine at the University of Tokyo. Those who were eligible for the study were informed of the purpose and procedure of the study and were asked for their voluntary participation in the study. Individual written informed consent was obtained from all participants prior to interviews. Confidentiality was protected at all stages of the data analyses.

Results

Response rate

The interview response rate was 92.7% (153/165) in the VMW village and 95.8% (159/166) in the HC village. Socio-demographic characteristics of the respondents in the VMW village and the HC village are described in Table 1. Occupation, monthly income, first treatment source and distance from the health facility differed significantly between the two villages.

Reported knowledge about malaria

The survey demonstrated the similar levels of knowledge on the cause of malaria symptoms, government-recommended antimalarial, and malaria risk populations between the VMW village and the HC village (Table 2). About 67% of total respondents had correct knowledge about the cause of malaria in both villages. More than 60% of total respondents correctly answered all of three major malaria symptoms in both villages. About 27% in the VMW village and 22% in the HC village gave the correct name of the government-recommended drug. Unlike children under age 5, only about 46% in the VMW village and 54% in the HC village perceived pregnant women as being vulnerable to malaria infection.

Majority of the respondents took at least one action against malaria in both villages. However, type of personal protective measures and/or mosquito control measures varied considerably among respondents. Using an ITN (92.0% in both villages) was the most frequently reported preventive measures, followed by wearing long sleeves and trousers (49.0% in the VMW village and 43.4% in the HC village).

Malaria treatment-seeking behavior

The self-reported prevalence of fever within 30 days of the survey was 71.9% in the VMW village and 79.2% in the HC village. Table 3 shows similarities and differences in malaria treatment-seeking behavior between the VMW village and the HC village. In both villages, most fever patients (>90%) sought treatment outside the home. In the VMW village, of those who sought treatment outside the home during the most recent fever episode (n = 104), VMWs were the most frequently reported treatment source (40.4%), followed by the HC (27.9%) and a private clinic (20.2%). In the HC village, of those who sought treatment outside the home during the most recent fever episode (n = 124), the HC was the most frequently reported first treatment source (94.4%). Other reported treatment sources included drug sellers, NGO clinics/hospitals, ODHs, private pharmacies, and the provincial hospital.

Majority of the patients with malaria-like symptoms were biologically tested in both villages. In the VMW village, of the 104 patients who sought outside treatment, about 85% were biologically tested for malaria. In the HC village, of the 124 patients who sought outside treatment, 79% were biologically tested for malaria. In the VMW village, of 88 patients who had their blood tested, VMWs were the most frequently reported source of a biological diagnosis (43.2%), followed by the HC (31.8%) and a private clinic (20.5%). In the HC village, of 98 patients who had their blood tested, more than 90% reported having had a blood test at the HC, followed by a private clinic (3.1%) and an ODH (2.0%). In both villages, nearly 80% tested positive and about 19% tested negative.

A bivariate analysis showed a significant difference in the distribution of time before first malaria treatment between the two villages. In the VMW village, of 104 patients who sought outside treatment, 23.1% reported having received the first treatment on the same day as the fever onset. This was higher than the 10.5% in the HC village. In the VMW village, 33.7% received their first treatment on the day after the fever onset, compared to 64.5% in the HC village. In the VMW village, 43.3% received their first treatment two or more days after the fever onset, compared to about 25% in the HC village.

Table 1 Socio-demographic characteristics of the respondents

Characterictics (n=312)	VMW village (n=153)				HC village (n=159)				p
	Means	SD	n	%	Means	SD	n	%	
Age (years)*	37.8	13.3			38.4	13.7			0.696
Gender†									0.210
Male			41	26.8			33	20.7	
Female			112	73.2			126	79.3	
Marital status†									0.082
Married			117	76.5			134	84.3	
Not married			36	23.5			25	15.7	
Highest level of education†									0.173
Primary			70	45.8			89	56.0	
No education			60	39.2			48	30.2	
Secondary/High school			23	15.0			22	13.8	
Occupation‡									<.0001
Farmer			125	81.7			154	96.9	
Other plus none			28	18.3			5	3.1	
Number of household members*	4.8	2.1			4.9	1.9			0.765
Monthly income (USD)†									0.005
Monthly income<50			134	87.6			153	96.2	
50≤Monthly income			19	12.4			6	3.8	
First treatment source‡									<.0001
VMW			55	36.0			0	0	
HC			52	34.0			150	94.3	
Other health facilities			46	30.0			9	5.7	
Distance from health facility‡									<.0001
<2km			38	24.8			123	77.4	
2-5km			39	25.5			36	22.6	
>5km			76	49.7			0	0	

*Student *t*-test.
†Chi-square test.
‡Fisher's exact test.

Most of the patients with malaria-like symptoms reported having been treated with antimalarial drug in both villages (>80%). However, nearly half of them could not recall the name of the antimalarial taken. Of those who could recall the name of the antimalarial drug taken, A + M was the primary antimalarial drug taken, followed by Malarine in both villages.

Comparison of community knowledge about malaria, actions, and malaria treatment between the VMW village and the HC village

Multiple regression analyses demonstrated that the villagers perceived the VMWs' services equally as good as those provided by the health center (Table 4). After controlling for confounding factors, the following indicators did not show any statistical significance between two villages: community members' knowledge about malaria transmission (AOR = 0.60, 95% CI = 0.30-1.22) and government-recommended antimalarial (AOR = 0.55, 95% CI = 0.25-1.23), preventive and control measures taken by respondents (Beta = −0.191, p = 0.315), and time before the first treatment (Beta = 0.053, p = 0.721). However, knowledge about malaria symptoms was significantly lower in the village with VMWs than the village with a health center (AOR = 0.40, 95% CI = 0.19-0.83).

Discussion

The most important finding of this study was that villagers perceived VMWs' services equally as good as those provided by the health center in receiving malaria diagnosis and effective treatment. This is supported by the evidence that no significant differences

Table 2 Reported knowledge on malaria and action for malaria control

	VMW village (n=153)		HC village (n=159)		
	n	%	n	%	p
Knowledge on cause of malaria*†					0.937
Correct	102	66.7	106	67.1	
Wrong	51	33.3	52	32.9	
Knowledge on malaria symptoms*					0.802
Correct	98	64.1	104	65.4	
Wrong	55	36.0	55	34.6	
Name of government recommended antimalarial drug*					0.325
Correct	41	26.8	35	22.0	
Wrong	112	73.2	124	78.0	
Knowledge on vulnerable groups to malaria infection					
Under 5 years old*	109	71.2	118	74.2	0.556
Pregnant women*	70	45.8	85	53.5	0.173
Personal protective and mosquito control measures					0.574
No measures taken	8	5.2	13	8.2	
1 to 3	73	47.7	75	47.2	
4 to 6	72	47.1	71	44.7	

*Chi-square test.
†1 missing data in HC village.

were detected in community knowledge about malaria transmission and government-recommended antimalarial, varieties of preventive measures taken, and time before first malaria treatment between the VMW village and the HC village. Even in a remote and resource-poor village without public health facilities, VMWs contributed to provide effective antimalarial treatment with biological confirmation and to disseminate accurate information about malaria to community members.

The two villages however, showed different levels of knowledge on malaria symptoms. Community member's knowledge about malaria symptoms was significantly lower in the VMW village than that in the HC village. Nevertheless, more than one third could not answer all of three major malaria symptoms in the HC village as well. Due to the absence of the standard definition in assessing level and correctness of knowledge, it is difficult to directly compare our findings with other study findings. However, when just focusing on knowledge on fever as the prime malaria symptoms, community members in both villages were better informed than those in other studies [13,14].

Early recognition of malaria symptoms is the first important step for prompting treatment-seeking behavior. VMWs, as well as the HC staff, need to enhance community knowledge about malaria symptoms to improve access to timely and appropriate treatment before becoming severe.

Unlike knowledge on malaria symptoms, the VMW village and the HC village showed similar levels of knowledge on malaria transmission. Our finding shows that most respondents in both villages were aware that malaria is transmitted through mosquito bites. This is in line with previous studies, which showed high level of knowledge on cause of malaria among community members [13,14]. Nevertheless more than 30% did not know that mosquito bites are the only route for malaria transmission in both villages. The similar result was observed in Tanzania, where only 35% of the respondents believed that mosquito alone are responsible for malaria [15]. As observed in rural Ethiopia, many had misconceptions regarding aetiology of malaria such as lack of hygiene, although they recognized role of mosquitoes in the malaria transmission cycle [16]. VMWs and the health center could make greater efforts to help the community understand the causal connection between mosquito bites and malaria transmission.

Although malaria in pregnancy has devastating effects not only on mothers but also on newborns and infants, pregnant women were not widely perceived as a group at high risk of malaria infection in both villages [17]. While more than 70% of respondents from each village understood that children under 5 are susceptible to malaria infection, only about half of them knew that pregnant women are also at high risk. A recent systematic review of qualitative research demonstrated perceived vulnerability of malaria in pregnancy is specific to the local context

Table 3 Prevalence of fever 30 days prior to the survey and relevant treatment-seeking behavior

Treatment -seeking behavior for malaria	VMW village		HC village		
	n	%	n	%	p
Patients who sought treatment outside home*	**n=110**		**n=126**		0.101
Yes	104	94.6	124	98.4	
No	6	5.5	2	1.6	
Treatment source*	**n=104**		**n=124**		<.0001
VMW	42	40.4	0	0	
HC	29	27.9	117	94.4	
Private clinic	21	20.2	4	3.2	
Drug seller	5	4.8	1	0.8	
Other	7	6.7	2	1.6	
Blood test for malaria*	**n=104**		**n=124**		0.570
Yes, Dipstick/Sldie	88	84.6	98	79.0	
Not tested	15	14.4	24	19.4	
Don't know	1	1.0	2	1.6	
Place to get the blood test*	**n=88**		**n=98**		<.0001
VMW	38	43.2	0	0	
HC	28	31.8	93	94.9	
Private clinic	18	20.5	3	3.1	
Other	4	4.6	2	2.0	
Result of the blood test*	**n=88**		**n=98**		1.000
Positive	70	79.6	78	79.6	
Negative	17	19.3	19	19.4	
Don't know/don't remember	1	1.1	1	1.0	
Time to receive first treatment†	**n=104**		**n=124**		<.0001
Same day	24	23.1	13	10.5	
Next day	35	33.7	80	64.5	
2 days after the illness started	31	29.8	23	18.6	
3 or more days after the illness started	14	13.5	8	6.5	
Antimalarial drugs†	**n=104**		**n=124**		0.032
Yes	98	94.2	106	85.5	
No	6	5.8	18	14.5	
Type of antimalarial taken*	**n=98**		**n=106**		0.555
A+M	25	25.5	26	24.5	
Malarine	14	14.3	14	13.2	
Antimalalrial drugs not recommended	8	8.2	4	3.8	
Paracetamol	7	7.1	5	4.7	
Don't know/don't remember	44	44.9	57	53.8	

*Fisher's exact test.
†Chi-square test.

[18]. While many studies have demonstrated that pregnant women are particularly vulnerable to malaria infection, their vulnerability is often underestimated as observed in this study, which can place them at even higher risk of infection. Maternal infection in low malaria transmission areas is more likely to result in symptoms, severe disease, and death of the mother or foetus than in high transmission areas [17]. To improve maternal, neonatal and child health in the community, it is crucial that community members understand vulnerability of pregnant women and adverse effects of maternal infection on birth outcomes.

Table 4 Comparison of community knowledge, action, and malaria treatment between the VMW and the HC villages

		Adjusted Odds Ratio	95%CI		β	p
			Lower	Upper		
Knowledge about the cause of malalria*	VMW(n=153)	0.60	0.30	1.22		
	HC(n=158)					
Knowledge about malalria symptoms*	VMW(n=153)	0.40	0.19	0.83		
	HC(n=159)					
Knowledge about government-recommended drug*	VMW(n=153)	0.55	0.25	1.23		
	HC(n=159)					
Preventive and control measures taken†	VMW(n=110)				-0.191	0.315
	HC(n=124)					
Time before first treatment†	VMW(n=110)				0.053	0.721
	HC(n=124)					

*Multiple logistic regression and †multiple regression, controlling for potential confounders (age, sex, marital status, education, occupation, the number of household member, income, first treatment source, distance from health facility).

In addition, a large number of respondents could not give the correct name of the government-recommended antimalarial drug in both villages. This result is discordant with the findings observed in other study, where more than 80% of the respondents had knowledge about the names of currently used drug [19]. During the interviews, many respondents tend to recall the name of commercialized antimalarial (Malarine), even though they took antimalarial recommended by government (A + M). This is because Malarine can easily be associated with malaria. Labelling drug packages with user-friendly name such as Malarine may help community members understand and use recommended antimalarial drug.

Various malaria preventive measures were taken in both VMW and HC villages. However, many of those measures seem to be not directly effective or environmentally harmful— such as using insecticide spray, using conventional mosquito nets, and drinking clean/boiled water. This may be partly explained by the fact that VMWs' training has been less focused on prevention and vector control than diagnosis and treatment [12]. Another possible explanation is that many of community members did not fully recognize mosquito bites as the only cause of malaria transmission. Evidence from Côte d'Ivoire reported that perceived cost was related to the use of preventive measures [13]. Since community members are motivated to take preventive actions, well-organized educational campaigns may help them take cost-effective, environmentally friendly, and sustainable malaria preventive measures such as draining stagnant water and alternating wet/dry irrigation in rice cultivation.

The vast majority (> 90%) sought treatment outside home in both villages. Unlike evidence from northern areas of Pakistan, home remedies and traditional healers were uncommon as first treatment source [20]. In this study, VMWs were a primary treatment source for malaria-like symptoms in the VMW village. Our findings showed that 40% of fever cases were first treated by VMWs, even though the health center is assumed to have better disease management capacity. This may be due to better accessibility of VMWs compared to the health center. Our result is consistent with the finding of the study conducted in Uganda, which also reported the same rate of CHW's utilisation in case of fever in the preceding month [21]. On the other hand, another study reported much lower rate (24%) of CHW's utilization in case of febrile illness [4].

Recently CHWs are increasingly called on to manage treatment of not only malaria but also other non-malaria febrile illnesses notably pneumonia and other cause of child mortality [1]. This strategy, known as integrated community case management (iCCM) of childhood illness, may increase the use of VMWs as observed in Nepal [22]. In Cambodia, VMWs' disease management capacity has been expanded to treat Acute Respiratory Infections (ARI) and diarrhea since 2009. A recent study showed that the quality of VMWs' services was maintained high even after the scale-up [23]. Future research is needed to evaluate the impact of the scale-up of the programme on the utilization of VMWs, as well as on morbidity and mortality of diarrhea and ARI.

Furthermore, in this study, the elapsed time before seeking the first malaria treatment was long. The two villages did not differ significantly in this regard. While about 57% in the VMW village and 75% received treatment within one day of the onset of symptoms, many waited until two or more days after the illness onset before seeking treatment, which could increase the probability of developing complications. Our finding, however, still encouraging compared to the results

observed elsewhere [4,24]. Since VMWs and the health center were the most frequently reported first line of contact in case of fever, they should emphasize the importance of early diagnosis and prompt treatment with effective antimalarials within 24 hours of symptom onset, to avoid complications.

This study had three main limitations. First, it used self-reported data, which are susceptible to reporting bias. However, attempts were made to minimize this potential bias by pre-testing the questionnaire, training interviewers, and making the wording culturally appropriate. Second, the study was not able to explore cause-effect relationships because of the cross-sectional study design. It, thus, could not address the effectiveness of VMW services in improving malaria treatment, community knowledge, and preventive measures. Third, only one VMW village and one HC village were surveyed in this study. Further research with better sampling method and increased sample size should be conducted in other malaria endemic areas in Cambodia to confirm our findings.

Nevertheless, this study provides important information on the quality of VMWs' services by assessing knowledge, action, and treatment-seeking behavior for malaria among community residents, who are consumers of their services. This information will be useful for improving malaria case management at community level, especially among marginalized populations in underserved remote areas.

Conclusions

VMWs successfully played an equivalent role as the health center in promoting malaria knowledge and action even in a resource-poor village without health center services. Although VMWs need to make greater efforts to enhance community knowledge about malaria symptoms, this study confirms that the current government policy on VMWs is reasonable and should be expanded to other villages, where malaria still remains a public health challenge.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

SL conceived the study, prepared the project proposal, developed the questionnaire, collected and analyzed data, and wrote the manuscript. JY contributed to the study design, data interpretation, and improvement of the manuscript. KCP reviewed and improved the manuscript. PL and CN trained surveyors and supervised fieldwork. MJ monitored progress of the study and provided guidance during fieldwork and the writing of the manuscript. All authors read and approved the final manuscript.

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Integrating child health services into malaria control services of village malaria workers in remote Cambodia: service utilization and knowledge of malaria management of caregivers

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Abstract

Background: Malaria and other communicable diseases remain major threats in developing countries. In Cambodia, village malaria workers (VMWs) have been providing malaria control services in remote villages to cope with the disease threats. In 2009, the VMW project integrated child health services into the original malaria control services. However, little has been studied about the utilization of VMWs' child health services. This study aimed to identify determinants of caregivers' VMW service utilization for childhood illness and caregivers' knowledge of malaria management.

Methods: A cross-sectional study was conducted in 36 VMW villages of Kampot and Kampong Thom provinces in July-September 2012. An equal number of VMW villages with malaria control services only (M) and those with malaria control plus child health services (M+C) were selected from each province. Using structured questionnaires, 800 caregivers of children under five and 36 VMWs, one of the two VMWs who was providing VMW services in each study village were interviewed.

Results: Among the caregivers, 23% in M villages and 52% in M+C villages utilized VMW services for childhood illnesses. Determinants of caregivers' utilization of VMWs in M villages included their VMWs' length of experience (AOR = 11.80, 95% confidence interval [CI] = 4.46-31.19) and VMWs' service quality (AOR = 2.04, CI = 1.01-4.11). In M+C villages, VMWs' length of experience (AOR = 2.44, CI = 1.52-3.94) and caregivers' wealth index (AOR = 0.35, CI = 0.18-0.68) were associated with VMW service utilization. Meanwhile, better service quality of VMWs (AOR = 3.21, CI = 1.34-7.66) and caregivers' literacy (AOR = 9.91, CI = 4.66-21.05) were positively associated with caregivers' knowledge of malaria management.

Conclusions: VMWs' service quality and length of experience are important determinants of caregivers' utilization of VMWs' child health services and their knowledge of malaria management. Caregivers are seeking VMWs' support for childhood illnesses even if they are providing only malaria control services. This underlines the importance of scaling-up VMWs' capacity by adding child health services of good quality, which will result in improving child health status in remote Cambodia.

Keywords: Malaria, Child health, Communicable diseases, Quality of service, Health service utilization, Community health worker, Cambodia

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Background

Despite growing concern over chronic non-communicable diseases, malaria and other communicable diseases remain major threats in developing countries. In Cambodia, more than three million people were at risk of malaria transmission and approximately 50,000 malaria cases were confirmed in 2010; this is the second highest number of any country in the Western Pacific Region. Moreover, Cambodia is among those countries suffering from multidrug-resistant malaria arising through the proliferation of artemisinin-tolerant malaria parasites [1-3]. Adding to the burden, the high-risk areas for malaria transmission are concentrated in remote forested areas which are common place to live among the poor, ethnic minorities and migrants who have limited access to public health services [4,5].

Cambodia has made marked progress to decrease under-five mortality from 117 to 43 deaths per 1,000 live births in the past 20 years, but it is still high compared to the regional average of 29 deaths per 1,000 live births [6]. Acute respiratory infections (ARI), diarrhoeal diseases, and febrile illnesses including malaria contribute to 30, 27, and 11% of under-five deaths, respectively [3,7]. Sociodemographic factors, such as living in remote areas, households' low level of wealth, and caregivers' low education level, are known to contribute to poor child health [3,7,8]. It is thus critically important to deliver effective childhood illness management interventions to these vulnerable households to improve the chances of child survival [9-11].

Adding to the communicable disease threats and burden of high under-five mortality, Cambodia is one of the 57 countries identified as facing a health workforce crisis and has been suffering from a severe health workforce shortage [12]. The country has the greatest subnational inequities in the distribution of medical doctors among the ten countries of the Association of Southeast Asian Nations (ASEAN) [13]. Most public health facilities are understaffed or do not have enough health care providers with sufficient clinical skills to deliver the services necessary in remote areas [14,15]. Consequently, most vulnerable populations do not have access to appropriate health services by well-trained health professionals.

Coverage of evidence-based interventions against communicable diseases is still low in Cambodia, especially in remote areas [15]. In such areas, community health workers (CHWs) indeed play a vital role in connecting communities to health services that are available, accessible, appropriate, and of good quality [16]. CHWs can play crucial roles to address the health workforce shortages, especially in low- and middle-income countries [17-20]. Moreover, when CHWs can provide integrated interventions rather than vertical single-disease initiatives, the child health outcomes are generally better in hard-to-reach and resource-poor settings, where a large percentage of child deaths occur [19,21-25].

CHWs are commonly sought out as the first-line of care in remote areas, whereas private clinics and private pharmacies are more commonly accessed in urban areas in Cambodia [7]. Therefore, strengthening the capacity of CHWs to provide good quality of care and to deliver the essential interventions represents one of the key ways to improve the public health status of remote village residents.

The Cambodian Government's National Centre for Parasitology, Entomology and Malaria Control (CNM) started a community-based malaria control project called the Village Malaria Worker (VMW) project as part of its National Malaria Control Programme in 2001 [4]. The VMWs are CHWs who were trained to effectively deliver malaria prevention and treatment services to remote villages. The VMW project was rolled out initially in 36 villages of a remote province, Rattanakiri. CNM staff members identified target VMW villages, each of which was located more than a 5-km or one-hour walk from the nearest public health centre. As part of the process, then and now, two villagers (one male and one female) are selected as VMWs in each village through community consensus. The VMWs are then trained in malaria control interventions including prevention, diagnosis, and treatment. The CNM staff members and district health officers supply essential items, such as rapid diagnostic tests (RDTs) and artemisinin combination therapy (ACT), and they supervise and monitor VMW activities monthly [4,26].

The VMW project has been gradually scaled up and now plays an important role in reducing malaria morbidity and mortality [3]. It was expanded to 315 villages in seven provinces in 2004, further extended to 1,394 villages in 2009, and finally reached 1,528 villages in 17 provinces in 2012. The VMW project has improved knowledge and practices of VMWs to prevent malaria and to provide early diagnosis and treatment in remote malaria endemic villages [16,27]. VMWs can now provide malaria control services comparable in quality to those of the local health facilities [28]. In March 2011, the government of Cambodia formally committed itself to eliminate malaria by the year 2025, identifying the VMW project as one of the key strategies to meet that goal [4].

The VMW project added child health services on top of their malaria control services starting in 2009 [3,8]. VMWs in 400 villages, who had been trained and started providing malaria control services by 2008, were given an additional training to provide child health services in 2009. This new approach was technically and financially supported by the World Health Organization (WHO) and the Global Fund for AIDS, TB and Malaria (GFATM) [4]. Since VMWs had already experienced success in delivering the essential

interventions for malaria control in remote villages, they were then expected to deliver the essential interventions for childhood illnesses, too.

The additional roles of VMWs in implementing child health services are as follows: to manage childhood illnesses, to prescribe and provide basic medications (antibiotics; cotrimoxazole, antipyretics; paracetamol, oral rehydration salts (ORS) and zinc), to refer severe cases to the appropriate health centres, and to provide preventive education such as promotion of breastfeeding and sanitation skills. As a result, a total of 15,898 children received child health services from VMWs in 2011 [4,26].

At this stage, it is important to take stock and evaluate how the integration of malaria control services and child health services have influenced service providers and service users. VMWs in M villages only provide malaria control services, but villagers visited VMWs to seek care for childhood illnesses [4]. With respect to service providers, initial findings suggested that the integration has increased VMWs' motivation and improved the quality of their malaria control services [26]. However, no study has yet been conducted to focus on the experience of service users after the introduction of the new child health services elements. Therefore, this study aimed to identify determinants of caregivers' VMW service utilization for childhood illnesses. It also examined the association between VMWs' service quality and caregivers' knowledge of childhood malaria management.

Methods

Study area

A cross-sectional study was conducted in 36 villages of two remote malaria-endemic provinces in Cambodia: Kampot and Kampong Thom. These 36 villages were selected out of 212 villages included in the VMW project sites in these two provinces in Cambodia. Kampot is located about 150 km south and Kampong Thom about 160 km north of the capital city, Phnom Penh. Kampot and Kampong Thom are similar to each other in terms of several demographic and epidemiological factors, including population size (585,850 and 631,409) [29], under-five mortality rate (73 and 67 deaths per 1,000 births respectively, compared with the national average of 54 deaths) [7], and number of malaria positive cases per VMW village (2.7 and 2.6 cases per month respectively, compared with the average for all VMW villages of 2.5 cases monthly). In Kampot, there were 36 villages with malaria control services only (M villages) and 27 villages with both malaria control services and child health services (M+C villages), while in Kampong Thom, there were 137 M and 12 M+C villages.

From each province, 18 villages (nine M villages and nine M+C villages) were selected as study sites based on the distance from the nearest public health centres. To this end, a list of VMW villages in the selected two provinces was provided by CNM. The villages were then sorted by distance from the nearest public health centre. The nine farthest villages in each type of service group were selected from each province.

Participants

This study had two categories of participants. Members of the first category were primary caregivers of children under five years of age exhibiting any symptoms of ARI, diarrhoeal diseases, or febrile illnesses within the three months prior to the survey. In cases where there was more than one eligible child in a household, the child who had experienced symptoms most recently was selected as the focus of the questions. Caregivers under the age of 18 were excluded.

The sample size of caregiver participants was calculated using Power and Precision software (Biostat, Englewood, New Jersey, USA), based on 40% VMW service utilization in M villages [28] and the assumption of an approximately 10% higher utilization in M+C villages, with alpha set at 0.05 and 80% power. This resulted in a minimum sample size of 388 caregivers to be surveyed per service type. In order to counteract the effects of missing data, 400 caregivers per service type (200 from each province) were included in this survey. The sample size of each village was calculated based on population proportions.

Members of the second category were one of the two VMWs who was leading the VMW service activities in each study village.

In total, 800 caregivers and 36 VMWs were recruited from 36 villages in two provinces.

Data collection

Data were collected from July to September 2012. The data collection period coincided with Cambodia's heavy rainy season, when malaria transmission reaches its peak, and ARI and diarrhoea incidences among children likewise swell.

One supervisor and seven interviewers were hired and trained to conduct face-to-face interviews. All of the interviewers were native speakers of the Khmer language, were fully conversant in and sensitive to the cultural context of the study site, and had experience in conducting malaria-related household surveys in remote villages.

To identify the determinants of the service utilization and caregivers' knowledge of childhood malaria management among those who live geographically available distance from the VMW services, the starting point for sampling household in each village was set at the VMW's residence. Seven interviewers started sampling from the nearest house from the VMW's residence and visited the next closest house to the last house sampled until the target sample size of each village was reached.

Measures

A total of 800 caregivers and 36 VMWs (one from each study village) were interviewed, using structured questionnaires. Both caregiver- and VMW-targeted questionnaires were prepared originally in English, translated into Khmer, and then back-translated into English by Cambodian public health and malaria experts to ensure content fidelity. A pre-test was conducted prior to the survey in a village near to and of comparable demographic composition to the study site.

Dependent variables were caregivers' utilization of VMW services and caregivers' knowledge of childhood malaria management. To measure caregivers' utilization of VMW services, caregivers were first asked "Have any of your children under five had fever, diarrhoea or fast/difficult breathing in the last 3 months" and then asked "Have you taken your children to a VMW to seek treatment?". The following symptoms defined as ARI related symptoms: cough, sore throat, runny nose, difficult breathing, and fast and short breathing [7]. Diarrhoeal diseases were defined as three or more semi-liquid stools or bloody semi-liquid stools over a 24-hour period [30]. Febrile illnesses included suspected cases of malaria were defined broadly as diseases associated with fever [7].

Caregivers' knowledge of childhood malaria management was measured by the malaria knowledge index. This index was developed based on caregivers' answers to survey questions regarding five aspects of malaria-related knowledge: prevention, cause, symptoms, diagnosis, and treatment [31-33]. One point was awarded for each correct answer, and knowledge of each aspect was assessed by a single item score Item scores were summed to yield the total score for the resulting five-item index, Cronbach's alpha for which was 0.71. Scores on this knowledge index were divided into two categories, high and low, with the cutoff point set based on the median.

Independent variables included VMW's service quality, which was measured by using a quality index [26,33] based on VMWs' answers to survey questions. The quality index composed of five items: active detection, diagnosis and treatment, perception of anti-malarials, follow-up, and dissemination of preventive measures. Item scores were summed to create the five-item index, Cronbach's alpha for which was 0.60. VMWs who had score equal to or higher than median were considered to be providing better quality of service in each M and M+C village.

Data on the sociodemographic characteristics of caregivers and their children were obtained using the household and women questionnaires of the Cambodia Demographic and Health Survey (CDHS) 2010 [7]. Caregivers were assigned to socio-economic status terciles based on household assets and housing characteristics determined by principal component analysis [34]. Caregivers' care-seeking behaviour was measured using the CDHS and integrated management of childhood illness multi-country evaluation household survey questionnaire [7,32].

Data on VMWs' characteristics and experience including age, sex, occupation, length of education, and working experiences were collected using a VMW survey questionnaire developed with reference to previous relevant studies [26,33]. Distance from the nearest health centre to each village was obtained from the official records collected by the VMW project.

Data analysis

Data from 800 caregivers and 36 VMWs were used to examine the benefits of VMW services for childhood illness management in remote villages of Cambodia. As M and M+C villages varied in their characteristics, results for the two village types were analysed separately except for the items pertaining to common service elements.

Differences between caregivers who used VMW services and those who did not were analysed by T-tests and Chi-square tests. To identify the determinants of VMW service utilization, multiple logistic regression analysis was conducted, adjusting for potential confounders. Another multiple logistic regression analysis was conducted to identify the relationship between caregivers' knowledge of childhood malaria management and VMW's service quality.

All continuous variables were converted to dichotomous variables at the point of the sample median for multiple logistic regression analysis [35]. The Variance Inflation Coefficient and the Spearman rank order correlation were used to assess multicollinearity between potential confounders for regression analysis; a rho of 0.5 or higher was taken as an indication of multicollinearity [36]. Statistical significance was set at p-value less than 0.05. All statistical analyses were performed using PASW18 (SPSS Inc, Chicago, Illinois, USA).

Ethical considerations

Ethical approval was obtained from the Research Ethics Committee of the Graduate School of Medicine, the University of Tokyo (the approval number: 3828). The study protocol, consent form, information sheet, and survey questionnaires were also reviewed by the CNM Institutional Review Board, National Ethics Committee for Health Research, Cambodia, which issued an exemption letter. All participants were provided with information regarding the study prior to the survey and participated voluntarily. Written informed consent was obtained and confidentiality assured for all the participants.

Results

Sociodemographic characteristics of participants

In total, 800 caregivers participated in this study (Table 1). All participants were of Khmer ethnicity and 91.6% of them were farmers. The majority of the primary caregivers

Table 1 Sociodemographic characteristics and care-seeking behavior of participants

Variables	Total (n=800)		M (n=400)		M+C (n=400)		
	n/($\bar{X}$)	%/(SD)	n/($\bar{X}$)	%/(SD)	n/($\bar{X}$)	%/(SD)	p-value
Caregiver's age (years) (Mean:$\bar{X}$, SD)	(29.8)	(7.8)	(29.9)	(8.1)	(29.7)	(7.5)	0.818
Number of children U5 (Mean:$\bar{X}$, SD)	(1.3)	(0.5)	(1.2)	(0.4)	(1.3)	(0.5)	0.001
Distance from health centre (km) (Mean:$\bar{X}$, SD)	(27.0)	(23.0)	(22.3)	(20.9)	(31.7)	(24.0)	<0.001
Caregiver's literacy							
Illiterate	394	49.3	159	39.8	235	58.8	<0.001
Literate	406	50.8	241	60.3	165	41.3	
Caregiver's wealth index							
Low	211	26.4	96	24.0	115	28.8	<0.001
Middle	340	42.5	149	37.3	191	47.8	
High	249	31.1	155	38.8	94	23.5	
VMW's experience (months) (Mean:$\bar{X}$, SD)	(60.7)	(28.5)	(37.9)	(5.5)	(83.5)	(23.4)	<0.001
Know VMW in village							
Yes	754	94.3	360	90.0	394	98.5	<0.001
Ever used VMW services							
Yes	599	74.9	276	69.0	323	80.8	<0.001
Used VMW for childhood illnesses*							
Yes	298	37.3	91	22.8	207	51.8	<0.001
Child age (months) (Mean:$\bar{X}$, SD)	(27.8)	(16.0)	(29)	(15.9)	(27)	(16.0)	0.083
Most recent symptoms							
ARI related symptoms	696	87.0	361	90.3	335	83.8	0.006
Diarrhoea	238	29.8	93	23.3	145	36.3	<0.001
Fever/Malaria	627	78.4	321	80.3	306	76.5	0.198
First health care provider for ARI related symptoms (n=696)							
VMW	241	34.6	71	19.7	170	50.7	<0.001
Public	103	14.8	89	24.7	14	4.2	
Private**	313	45.0	181	50.1	132	39.4	
Home care	39	5.6	20	5.5	19	5.7	
First health care provider for Diarrhoea (n=238)							
VMW	70	29.4	8	8.6	62	42.8	<0.001
Public	41	17.2	30	32.3	11	7.6	
Private**	110	46.2	48	51.6	62	42.8	
Home care	17	7.1	7	7.5	10	6.9	
First health care provider for Fever/Malaria (n=627)							
VMW	223	35.6	75	23.4	148	48.4	<0.001
Public	87	13.9	70	21.8	17	5.6	
Private**	262	41.8	148	46.1	114	37.3	
Home care	55	8.8	28	8.7	27	8.8	
Severity of symptoms							
Mild	199	24.9	112	28.0	87	21.8	0.120
Moderate	441	55.1	210	52.5	231	57.8	
Severe	160	20.0	78	19.5	82	20.5	

Table 1 Sociodemographic characteristics and care-seeking behavior of participants *(Continued)*

Number of symptoms							
One	29	3.6	29	7.3	39	9.8	0.308
Two	56	7.0	56	14.0	63	15.8	
Three or more	315	39.4	315	78.8	298	74.5	

*Within three months prior to the survey.
**Private clinic, pharmacy, traditional healer and other private practices.

of children were mothers (95.8%) and were also involved in the decision-making process to seek care for childhood illnesses (mother only or both parents involved in decision-making process: 96.2%). Ages of caregivers ranged from 18 to 79 (mean 29.8) years. Distance from households to the closest public health centre ranged from 5 to 77 (mean 27.0) km. The number of household in each village varied from 41 to 793 (mean 214). Accordingly, the number of surveyed household per village varied from 6 to 63 (mean 22). Among the surveyed households, 76% had one, 23% had two, and 1% had three or more children under five. Compared to caregivers from M villages, caregivers from M+C villages had larger numbers of children under five years at home (M 1.2 *vs* M+C 1.3, p = 0.001), lived farther from the closest public health centre (M 22.3 km *vs* M+C 31.7 km, p <0.001), had lower education levels (illiterate: M 39.8% *vs* M+C 58.8%, p <0.001), and belonged to the low wealth category (M 24.0% *vs* M+C 28.8%, p <0.001).

VMWs from 36 villages (18 villages from each province) also participated in the study. Of them, 18 were providing M services, while the other 18 were providing M+C services. All of the VMWs were farmers, and 70% were male. The age of VMWs ranged from 20 to 66 (mean 42.4) years. The mean length of education VMWs had received was 5.8 years. The length of VMWs' working experience providing services in the villages ranged from 32 to 100 (mean 60.7) months. Caregivers in M villages were in contact with VMWs having fewer months of working experience compared to caregivers in M+C villages (M 37.9 months *vs* M+C 83.5 months, p <0.001). The majority of caregivers (94.3%) knew the designated VMWs (M 90.0% *vs* M+C 98.5%, p <0.001) of their villages. Utilization rates for VMW services were higher in M+C villages compared to those in M villages (ever used VMWs services: M 69.0% *vs* M+C 80.8%, p <0.001; used VMWs' child health services within the three months prior to the survey: M 22.8% *vs* M+C 51.8%, p <0.001).

Ages of children ranged from two to 59 (mean 27.8) months. The numbers of reported symptoms of ARI, diarrhoeal diseases and febrile illnesses occurring over the past three months prior to the survey were 696 (87.0%), 238 (29.8%), and 627 (78.4%), respectively. Private practices (private clinics, pharmacies, traditional healers and others) were the most common sources of care providers used by caregivers for the various childhood illnesses in M villages (ARI related symptoms: 50.1%, diarrhoea: 51.6%, fever: 46.1%), whereas VMWs were the most commonly used in M+C villages (ARI related symptoms: 50.7%, diarrhoea: 42.8%, fever: 48.4%). Compared to children from M villages, a higher proportion of children from M+C villages had experienced diarrhoea (23.3 *vs* 36.3%, p <0.001), while a lower proportion had experienced ARI related symptoms (90.3 *vs* 83.8%, p = 0.006).

Sociodemographic characteristics and determinants of service utilization in M villages

Among 400 caregivers in M villages, 91 (22.8%) had utilized VMW services for their children's illnesses within the three months prior to the survey (Table 2).

The factors associated with VMW service utilization in M villages were as follows. Compared to caregivers whose VMWs had fewer years of education, caregivers whose VMWs had more years of education were twice as likely to have utilized VMW services (adjusted odds ratio [AOR] = 2.00; 95% confidence interval [CI] 1.05-3.83, p <0.036). Caregivers whose VMWs had longer (41.5 months or more) working experience as a VMW were more likely to have utilized VMW services compared to caregivers whose VMWs had shorter (less than 41.5 months) experience (AOR = 11.80; 95% CI 4.46-31.19, p <0.001). Compared to caregivers whose VMWs had lower service quality, those having VMWs with higher service quality were twice as likely to have utilized VMW services (AOR = 2.04; 95% CI 1.01-4.11; p = 0.046). Caregivers living farther (9.5 km or farther) from the nearest public health centre, meanwhile, were more likely to have utilized VMW services compared to caregivers living closer (less than 9.5 km) to the nearest public health centre (AOR = 3.03; 95% CI 1.44-6.37; p = 0.004).

On the other hand, compared with having a child who had malaria or fever most recently, having a child whose most recent symptoms fell into other categories were 63% less likely to have used VMW services (AOR = 0.37; 95% CI 0.16-0.87; p = 0.022). Further, compared to caregivers of children with mild symptoms, caregivers of children with moderate symptoms (AOR = 0.40; 95% CI 0.21-0.76; p = 0.005) and severe symptoms (AOR = 0.20; 95% CI 0.08-0.47; p < 0.001) were less likely to have utilized VMW services.

Table 2 Determinants of VMW service utilization by caregivers in M villages (n=400)

Factors	VMW service		AOR	(95% CI)	p-value
	Users (n=91)	Non-users (n=309)			
VMW's education					
<5 years	40	168			
≥5 years	51	141	2.00	(1.05-3.83)	0.036
VMW's experience					
<41.5 months	13	187			
≥41.5 months	78	122	11.80	(4.46-31.19)	<0.001
VMW's service quality					
<4.1 points	27	229			
≥4.1 points	64	80	2.04	(1.01-4.11)	0.046
Caregiver's age					
<28 years	55	162			
≥28 years	36	147	0.92	(0.50-1.68)	0.777
Number of children U5					
One	79	245			
Two or more	12	64	0.65	(0.30-1.45)	0.296
Distance from nearest public health centre					
<9.5 km	44	156			
≥9.5 km	47	153	3.03	(1.44-6.37)	0.004
Caregiver's literacy					
Illiterate	34	125			
Literate	57	184	0.66	(0.351-1.24)	0.194
Caregiver's occupation					
Farmer	86	277			
Other	5	32	0.89	(0.28-2.83)	0.846
Caregiver's wealth index					
Low	19	77			
Middle	36	113	0.91	(0.45-1.85)	0.797
High	36	119	0.73	(0.36-1.49)	0.386
Child age					
<12 months	17	55			
12-59 months	74	254	1.04	(0.50-2.18)	0.918
Most recent symptom was Fever/Malaria					
Yes	81	240			
No	10	69	0.37	(0.16-0.87)	0.022
Severity of symptoms					
Mild	39	73			
Moderate	39	171	0.40	(0.21-0.76)	0.005
Severe	13	65	0.20	(0.08-0.47)	<0.001
Number of symptoms					
One	9	20			
Two	9	47	0.56	(0.16-2.01)	0.374
Three or more	73	242	0.72	(0.50-1.68)	0.530

Sociodemographic characteristics and determinants of service utilization in M+C villages

Among 400 caregivers in M+C villages, 207 (51.8%) had utilized VMW services for their children's illnesses within the three months prior to the survey (Table 3).

The factors associated with VMW service utilization in M+C villages were as follows. Caregivers whose VMWs had longer (72 months or more) experience as a VMW were more likely to have utilized VMW services compared to caregivers whose VMWs had shorter (less than 72 months) experience (AOR = 2.44; 95% CI 1.52-3.94; p <0.001).

On the other hand, living farther (25.5 km or more) from the nearest public health centre was negatively associated with caregivers' utilization of VMWs' services (AOR = 0.35; 95% CI 0.21-0.56; p <0.001). Compared to caregivers who had low wealth index scores, caregivers on the high end of the index were 65% less likely to have utilized VMW services (AOR = 0.35; 95% CI 0.18-0.68; p = 0.002). However, quality of VMW services was not significantly associated with service utilization in M+C villages (AOR = 0.84; 95% CI 0.51-1.38; p = 0.487), nor were any of the child-related factors.

Caregivers' Knowledge of childhood malaria management

Most of the caregivers demonstrated accurate malaria knowledge (Table 4). For example, they knew that mosquito bites cause malaria (98.4%), that bed nets should be used while sleeping to prevent malaria transmission (99.4%), that mosquito bites should be avoided (97.5%), that shivering (98.9%) and high fever (97.3%) are the main symptoms of malaria, that malaria is diagnosed by checking the blood (99.0%), and that anti-malarial drugs are the method of treatment (85.6%).

At the same time, some of them also believed in inaccurate information related to malaria management. Only about half of the caregivers understood that malaria cannot be transmitted through coughs or sneezes (58.6%), or by touching the blood of someone with malaria (48.4%). Similarly, only half understood that staying physically apart from malaria patients cannot prevent malaria (55.3%), and less than half correctly noted that malaria cannot be diagnosed from the mere presence of high fever (35.8%) or by a health care provider's simple observation alone (23.5%). Moreover, more than a fourth of the caregivers believed that food poisoning or witchcraft

Table 3 Determinants of VMW service utilization by caregivers in M+C villages (n=400)

Factors	VMW service		AOR	(95% CI)	p-value
	Users (n=207)	Non-users (n=193)			
VMW's education					
<4 years	127	73			
≥4 years	80	120	1.48	(0.95-2.31)	0.085
VMW's experience					
<72 months	85	119			
≥72 months	122	74	2.44	(1.52-3.94)	<0.001
VMW's service quality					
<4.2 point	85	91			
≥4.2 point	122	102	0.84	(0.51-1.38)	0.487
Caregiver's age					
<28 years	114	94			
≥28 years	93	99	0.82	(0.51-1.30)	0.397
Distance from nearest public health centre					
<25.5 km	127	73			
≥25.5 km	80	120	0.35	(0.21-0.56)	<0.001
Caregiver's literacy					
Illiterate	117	118			
Literate	90	75	0.98	(0.58-1.65)	0.943
Caregiver's occupation					
Farmer	198	172			
Other	9	21	0.43	(0.17-1.05)	0.062
Caregiver's wealth index					
Low	69	46			
Middle	102	89	0.63	(0.37-1.07)	0.089
High	36	58	0.35	(0.18-0.68)	0.002
Child age					
<12 months	36	46			
12-59 months	171	147	1.29	(0.17-2.23)	0.358
Most recent symptom was Fever/Malaria					
Yes	158	148			
No	49	45	0.96	(0.56-1.62)	0.866
Severity of symptoms					
Mild	51	36			
Moderate	121	110	0.75	(0.43-1.31)	0.312
Severe	35	47	0.52	(0.25-1.05)	0.068
Number of symptoms					
One	21	18			
Two	30	33	1.01	(0.41-2.48)	0.979
Three or more	156	142	1.29	(0.61-2.74)	0.511

Table 4 Malaria knowledge of caregivers (Items of malaria knowledge index) (n=800)

Items		n	%
Transmission route	Mosquito bite (Yes)	787	98.4
	Coming close to malaria patient (No)	608	76.0
	Sharing food with malaria patient (No)	599	74.9
	Food poisoning/witchcraft (No)	592	74.0
	Cough and sneeze of malaria patient (No)	469	58.6
	Touching blood of malaria patient (No)	387	48.4
Prevention	Sleep under the bed net (Yes)	795	99.4
	Avoid mosquito bite (Yes)	780	97.5
	Wear long-sleeved shirts/pants (Yes)	757	94.6
	Clean bush around house (Yes)	731	91.4
	Cover water jars/tanks (Yes)	706	88.3
	Come back home before dawn (Yes)	664	83.0
	Use mosquito coil (Yes)	662	82.8
	Don't go close to malaria patient (No)	442	55.3
Symptom	Shivering (Yes)	791	98.9
	High fever (Yes)	778	97.3
	Headache (Yes)	735	91.9
	Sweating (Yes)	682	85.3
Diagnosis	Blood check (Yes)	792	99.0
	Only high fever (No)	286	35.8
	Only observation of provider (No)	188	23.5
Treatment	Anti-malarial drug (Yes)	685	85.6
	Antibiotic (No)	551	68.9
	Home remedy (No)	556	69.5

could cause malaria (food poisoning or witchcraft cannot cause malaria: 74.0%).

Determinants of knowledge on childhood malaria management

Caregivers of a child who had experienced fever or malaria symptoms most recently and who had sought care from VMWs as the first health care provider in M and M+C villages were included in the analysis to determine factors associated with knowledge of childhood malaria management (Table 5). Out of 223 eligible caregivers, 123 had high levels of knowledge and 100 had low levels of knowledge ("high" and "low" groups were created based on the median [3.92] knowledge index score).

Caregivers whose VMWs had higher service quality exhibited higher knowledge levels on childhood malaria

Table 5 Factors associated with knowledge of childhood malaria management of caregivers (n=223)

Factors	Malaria knowledge*		AOR	(95% CI)	p-value
	High (n=123)	Low (n=100)			
VMW's education					
<5 years	61	56			
≥5 years	62	44	2.00	(0.98-4.08)	0.057
VMW's experience					
<72 months	78	56			
≥72 months	45	44	0.61	(0.29-1.32)	0.212
VMW's service quality					
<4.2 points	27	53			
≥4.2 points	96	47	3.21	(1.34-7.66)	0.009
Caregiver's age					
<27 years	68	47			
≥27 years	55	53	1.87	(0.84-4.17)	0.128
Household size					
<4 person	70	44			
≥4 person	53	56	0.93	(0.44-1.96)	0.840
Distance from nearest public health centre					
<10 km	78	35			
≥10 km	45	65	0.75	(0.33-1.72)	0.493
Caregiver's literacy					
Illiterate	30	75			
Literate	93	25	9.91	(4.66-21.05)	<0.001
Caregiver's occupation					
Farmer	117	95			
Other	6	5	0.38	(0.09-1.60)	0.186
Caregiver's wealth index					
Low	26	37			
Middle	63	42	1.24	(0.55-2.80)	0.598
High	34	21	0.89	(0.34-2.32)	0.804
Child age					
<12 months	25	17			
12-59 months	98	83	0.78	(0.33-1.84)	0.564

* Malaria knowledge divided into two categories; High/Low, at the median (=3.92) of malaria knowledge index.

management compared to caregivers whose VMWs had lower service quality (AOR = 3.21, 95% CI 1.34-7.66; p = 0.009). Literate caregivers were also nearly ten times more likely to have higher knowledge levels compared to illiterate caregivers (AOR = 9.91, 95% CI 4.66-21.05; p < 0.001).

Discussion

This study provides new insights into caregivers' utilization of VMWs' child health services in remote villages in Cambodia. First, the rates and determinants of VMW service utilization by caregivers were different between M villages and M+C villages. Second, the VMWs' service quality and their length of experience working as a VMW were important determinants for caregivers' utilization of child health services and their knowledge of childhood malaria control in VMW villages. Finally, some caregivers in M villages sought care for childhood illnesses from VMWs even though VMWs were technically providing only malaria control services.

The differences in VMW service utilization rates may be explained in part by the differences in circumstances under which villages were selected as VMW project sites and by discrepancies in the caregivers' sociodemographic characteristics between M and M+C villages. Namely, M+C villages were selected as VMW project sites before 2004 because of their location (remote and closest to forests where malaria vectors breed) and high risk for malaria transmission. In contrast, M villages were selected after 2009 to expand VMWs' malaria control services to villages at lower risk of malaria transmission but far (over 5 km) from public health centres [4]. The duration of VMW services being provided in M villages was much shorter compared to the situation in M+C villages. This could be one of the reasons that caregivers' awareness of VMWs' services was lower in M villages compared to M+C villages, as fewer caregivers had likely utilized VMW services in these settings. Additionally, one explanation for the much lower utilization rates observed in M than in M+C villages may be related to the limited range of services (only malaria control) available from VMWs in M villages as compared to M+C villages (malaria control services and childhood illness services).

The determinants of caregivers' VMW service utilization were different between M and M+C villages. Namely, in M villages, factors linked to higher VMW service utilization rates were largely related to the VMWs characteristics, including higher education levels (caregivers twice as likely to use VMW services), longer experience working as a VMW (12 times more likely), and high service quality (twice as likely). Moreover, farther distance (9.5 km or more) between caregivers' residences and the nearest public health centres was associated with a three times greater likelihood of utilizing VMW services for childhood fever or malaria with mild or moderate symptoms. This result could be related to the villages' locations (M villages were less remote than M+C villages) and that only malaria control services were available from VMWs in M villages. Overall, caregivers in M villages selected to utilize VMW services when they judged their VMWs were capable and that their children's conditions were appropriate to be treated by VMWs. An association between high quality of CHW services and high service utilization by caregivers has already been reported from remote and resource-poor settings including Nepal, Bangladesh, and Zambia [19,21,37-39].

On the other hand, in M+C villages, just three factors were significantly associated with caregivers' service utilization. First, caregivers whose VMWs had more years of working experience were about two times more likely than those whose VMWs had fewer years experience to have utilized their VMWs' services. Second, caregivers whose wealth index score was in the low or middle range were more likely than those on the high end of the wealth index to have utilized VMW services, possibly because such services were free and did not entail any extra transportation costs. Third, unlike the result from M villages and a previous study from Uganda [40], caregivers residing farther (25 km or more) from the nearest public health centre were less likely than caregivers residing closer to a public health centre to have utilized VMW services. Delays in medical supplies (VMWs in Kampong Thom province and Aya Hasegawa, personal communication, August 4, 5 and 6, 2012) could be one of the reasons for caregivers' low VMW utilization rate in farther villages. The basic medication supplies for childhood illness management (antibiotics; cotrimoxazole, antipyretics; paracetamol, ORS and zinc) have been less stable than those for malaria control (ACT and RDTs) in remote villages. Overall, more than 50% of caregivers had utilized VMWs' child health services within the three months prior to the survey in M+C villages. This could be because VMWs were sometimes the only health care provider available, in terms of affordability and accessibility, for caregivers in M+C villages. Under these circumstances, caregivers may be electing to utilize VMW services simply because such services are there.

The quality of VMWs' services was positively associated with caregivers' knowledge of childhood malaria management in VMW villages. Among caregivers whose children had fallen ill with fever or malaria, knowledge levels regarding childhood malaria management were about three times higher if the service provided by the local VMWs was of high quality compared to those who had VMWs with low service quality. The majority of caregivers had accurate knowledge of childhood malaria management but, at the same time, many also believed in spurious rumours or traditional sayings, for example, that "food poisoning or witchcraft" is a transmission route for malaria, or that not "going close to a malaria patient" could prevent malaria transmission. Caregivers' inaccurate perceptions or beliefs can sometimes cause delays in seeking care for childhood illnesses, which can lead to symptoms becoming more severe and more complicated [41,42]. Therefore, there is a clear need for VMWs to update caregivers' knowledge on childhood illness management so they can protect their children. Also, VMWs need to pass on accurate and up-to-date information to caregivers. The provision of close monitoring with prompt feedback, on-site supervision, and regular refresher training [25,33,39] by CNM staff members, in collaboration with local public health centre staff members, are necessary to improve the service quality of VMWs.

Among all study participants, about a third never attended school and roughly half were illiterate – rates higher than the corresponding national averages [7]. Moreover, literate caregivers were about ten times more likely to exhibit high knowledge levels regarding childhood malaria management than were illiterate caregivers. It is therefore important to improve childhood malaria management knowledge of caregivers. VMWs, as community members and the most commonly accessed health care providers in remote villages, are well suited to provide such knowledge to caregivers with user-friendly and culturally acceptable methods. VMWs' use of their own regional dialect and pictorial explanations, rather than reliance on printed information materials, could help substantially improve the knowledge of caregivers.

Notably, even though VMWs in M villages provided only malaria control services, caregivers in these villages also sometimes visited VMWs to seek care for their children's ARI or diarrhoeal diseases. Indeed, only providing malaria control services may not be enough, because about 90% of children had ARI related symptoms and 30% of children had diarrhoea in the study villages. Moreover, more than 90% of the children surveyed had experienced two or more symptoms at once. Previous studies have reported possible risks associated with providing treatment for a single disease in isolation. For example, the risk of providing malaria treatment for ARI cases led to delays in ARI treatment and thus created severe ARI cares in Zambia [43]. Similarly, difficulties in dealing with recurring childhood illnesses by CHWs trained to treat only a single disease were highlighted in studies from Tanzania, Nicaragua, and Bangladesh [27,44-46]. Hence, the concept of "integration" is important and may prove more effective than single-disease interventions [21-23,47]. The VMW project could be successfully scaled up in terms of the number of VMWs and the range of health services provided without degrading the quality of their malaria control services [26]. Against this backdrop, scaling up VMW capacities from malaria control services (M) to malaria control and child health services (M+C) can be an effective strategy to simplify care-seeking procedures for caregivers, providing a one-stop integrated intervention approach and minimizing the time to first diagnosis and treatment for sick children.

Findings from this study should be considered in the context of some limitations. First, because the field survey was conducted during Cambodia's heavy rainy season, accessibility of the villages had to be taken into consideration when selecting study sites. However, the farthest villages from public health centres were selected among the subset of accessible villages. Second, caregivers were asked about