

Developing the active larval indices surveillance system for dengue solution in low and high dengue risk primary care units, Southern Thailand

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Abstract

Purpose – The purpose of this paper is to develop an active larval indices surveillance system and compare the outcomes of the implementation in primary care units (PCUs) at low and high risk of dengue.

Design/methodology/approach – The study design was conducted by implementing a community participation action research system in low and high dengue risk PCUs in Lansaka district, Nakhon Si Thammarat province, in the Southern Region of Thailand. There were five phases to the process including preparation of all stakeholders, situation assessment, development of the surveillance system, program implementation and evaluation. The system was developed in ten villages that were categorized as either low dengue risk PCUs (comprising six villages) or high dengue risk PCUs (four villages). A village was assigned as being at high or low dengue risk according to pre-determined criteria. The low dengue risk PCU assessments were conducted on a seven-step active larval indices surveillance system where PCU officials were additionally involved in coordinating, teaching, coaching and supporting the village health volunteers (VHVs) for dengue prevention activities. The high dengue risk PCUs, on the other hand, only followed a basic larval indices surveillance system with no follow-up support.

Findings – The outcomes of using intervention systems showed that the VHVs' dengue knowledge and larval indices understanding in both PCUs increased significantly ($p < 0.01$). Furthermore, the low dengue risk PCUs had a higher larval indices level than the high dengue risk PCU ($p < 0.01$).

Originality/value – This study showed that the low dengue risk PCU followed an active larval indices surveillance system at the sub-district level which is appropriate for villages. This study also revealed that VHVs are needed to strengthen the capacity in terms of knowledge and skills of developing such a system to ensure reduced levels of dengue in the community.

Keywords Surveillance, Thailand, Dengue, Larval indices

Paper type Research paper

Introduction

Dengue has become a significant health problem in several countries around the world. An estimated 2.5bn people are at risk of infection, including approximately 975m who live in tropical and sub-tropical countries[1]. Dengue is also a significant health problem in Thailand; in the Southern part of the country there is both a high morbidity rate and high larval indices rate with higher reports of dengue being detected in this area compared with other areas of Thailand[2]. The Southern Region of Nakhon Si Thammarat province in particular is at a high risk of dengue fever outbreaks compared with other provinces in this region because of several factors including rainfall, temperature[1, 3], population density, varied types of dengue[4, 5], non-specific treatment, unsuccessful implementation of the



dengue vaccine[1], ineffective specific drugs[1] and poor attitudes toward dengue prevention [6, 7]. Dengue transmission in the community is one important consideration, but it needs community participation to actively practice surveillance and prevention[8]. It also requires community capacity building[9] in order to better assess classical *Aedes* larval indices levels such as the House index (HI) – percentage to track houses infested with larvae, the Breteau index (BI) – number to track larvae positive containers per 100 houses inspected, a Container Index (CI)– percentage to assess water-holding containers infested with larvae, as well as morbidity rate data[10]. Larval indices surveys which carry out an assessment of the community[1, 11], are practical, low cost, convenient, help prevent dengue and are used to evaluate dengue outcomes[12].

The Thai Ministry of Public Health (MOPH) proposed that the recommended classical larval indices rates should be $HI < 10$, $BI < 50$ and $CI < 1$ [13]. Vector surveillances are mostly carried out using larval surveillances giving larval indices. Surveillance activities are carried out by working groups of village health volunteers (VHVs), who are coordinated by primary care units (PCU)[14]. The activities involve routine roles such as larval surveys, destruction of mosquito breeding sources and dengue death prevention campaigns if sufficient budgets are available. There was no sustainability in these areas because of the short time and lack of community participation. Moreover, routine work and studies of the dengue problem need more than three years[15]. PCUs were responsible for training the VHVs; but some VHVs sometimes missed surveys, failed to calculate indices levels and occasionally failed to understand the meaning of their surveys. Moreover, each PCU did not show the larval indices levels to all VHVs or peoples in the community[12].

According to the above, the vector surveillance in Thai was evidently a passive surveillance that involved routine work. In order to improve results, it needs an enhanced active surveillance system since studies of relevant literature reviews state that passive surveillance systems can be improved with data forms, electronic-based reporting, performing data analysis at district level and data feedback[16].

Kamlon sub-district in Lansaka district, Nakhon Si Thammarat province has had a dengue problem for some time. The dengue morbidity rate in Kamlon sub-district has been higher than other sub-districts for the last five years with 1,243, 11, 86, 637 and 126 cases/100,000 inhabitants in the years 2010, 2011, 2012, 2013 and 2014, respectively[17]. The larval indices survey showed many barriers to dengue prevention and control. This study aims to develop the larval indices surveillance system for low and high dengue risk PCUs and compare the outcomes of implementing active larval indices surveillance systems in low and high dengue risk PCUs.

Methodology

The study was received and forwarded to the Institutional Review Board, the Ethical Review Committee for Research Subjects, the Health Science Group, Walailak University, Thailand, protocol number 13/047 on 29 August, 2013.

Study area

The study included ten villages that were separated into low and high dengue risk PCUs. The village level assessment of dengue risk identifiers included the following two factors: first, the “severity factor” that assessed the severity of dengue outbreaks in the past five years. This was assessed according to three criteria. Second, the “opportunity factor” assessed the factors related to the opportunities for the outbreak of dengue incidents. These were also assessed according to three criteria. The importance of both factors in assessing dengue risks need to be emphasized, particularly in the areas of management[18]. Villages with low and high dengue risk were assessed using half of the total scores (14 of 28 scores)

of the severity factor and opportunity factors. Applying risk scores from the cut-off point can be categorized into the following two levels: if the score is ≥ 14 it can be categorized as high risk while < 14 scores were defined as low risk[19]. Additionally, the study setting area focused on ten villages comprising two PCUs: six villages (village numbers 1, 2, 3, 4, 7 and 12) were under the responsibility of a PCU showing low dengue risk levels and were, therefore, identified as the low dengue risk PCU; the remaining four villages (village number 5, 8, 9 and 10) that showed high levels of dengue risk were categorized under the high dengue risk PCU (Table I).

Methods

The Apply Community Participation Action Research (Apply CPAR)[20] approach was conducted over 18 months (year 2014–2015) and divided into five phases: preparation of all stakeholders in the district, situation assessment, development of the surveillance system, program implementation and evaluation.

The 1st phase involved community preparation. The research team mobilized all of the stakeholders in the sub-district. These stakeholders consisted of representatives from the sub-district health office, two PCUs, local administrative organizations (LAOs) and VHVs. The researcher provided the study objectives to the community leader, and collected consent forms from all participants for data collection and the inclusion of the larval indices survey in each selected household. The objectives, methods, measurements and utility of the study were described to the stakeholders as part of this step.

The 2nd phase was the situation assessment phase. Assessments included dengue knowledge and understanding of larval indices among VHVs as well as group leaders of the ten villages, interviews of senior VHVs, as well as a household environment survey. The assessment data were then used for developing and using the larval indices surveillance system.

The 3rd phase was the development of the surveillance system based on community participation and the community context. The activities included: the presentation of the situation assessment results; meeting with community leaders and VHVs for dengue and larval indices training; the grouping of VHVs to cover all of the areas in the ten village; the presentation of the larval indices surveillance system, the dengue record book for the larval indices survey; and the development of a computational program for the larval indices online calculation.

The 4th phase was composed of seven steps at the household level and four steps at the two PCUs. The steps at the household level were based on VHVs, PCUs and the community context, whereas the surveillance steps included: the production of source data groups, the

Dengue risk assessment criteria	Value (score)	Village number									
		Low dengue risk PCU						High dengue risk PCU			
		1	2	3	4	7	12	5	8	9	10
<i>1. Severity factor</i>											
1.1 Endemic area	1–5	2	3	3	3	3	2	3	3	2	3
1.2 Herd immunity in the community	1–5	1	1	1	1	1	2	5	2	5	2
1.3 Diseases incidence in current year	1–5	4	1	1	1	1	1	1	1	1	1
Value of severity factor	3–15	7	5	5	5	5	5	9	6	8	6
<i>2. Opportunity factor</i>											
2.1 Population movement	1–3	2	2	1	2	2	3	2	2	2	2
2.2 Density of population per area	1–5	3	4	3	3	3	3	5	2	3	4
2.3 Participation/ Community strength	1–5	1	1	1	1	1	1	4	4	4	4
Value of opportunity factor	3–13	6	7	5	6	6	7	11	8	9	10
Total score of severity and opportunity factors	6–28	13	12	10	11	11	12	20*	14*	17*	16*

Table I.
Village’s areas with low and high dengue risk PCUs

sub-district surveillance center (PCU), user data and larval indices information in the sub-district groups and practical guidelines for dengue problem solving.

The 5th phase involved the evaluation of the process and program outcomes. The research team and community participants monitored the system once a month. The resulting data were used as indicators to prevent a dengue outbreak in each village. The data for the surveillance system were collected for six months.

Assessment tool

In the assessment and evaluation phase, the study used questionnaires assessing basic knowledge of dengue that were developed and tested by the researcher. The content was validated by three experts in dengue prevention and the control showed CI = 0.86. The reliability confirmed with the 30 VHVs from the other district found Cronbach's α coefficient = 0.83. The format of the self-report consisted of two parts: Part I, general characteristics; Part II, basic knowledge. The survey took 15 min to complete and consisted of 15 items on dengue knowledge with three possible answers: yes, no and unknown. Questions concerned the cause of dengue, major signs of dengue, dangers of dengue, mosquito-bite prevention, the mosquito's life cycle and methods of mosquito elimination.

The larval indices surveillance system questionnaires were prepared in an open-ended format and comprised of three sections: personal information, sex, education level, experience, length of time in VHV role; understanding of larval indices surveillance with meaning, type, calculation and activities of larval surveillance (items no. 1–11); and problems, barriers and needs of VHV's in low and high dengue risk PCUs (items no. 12–14). The principal researcher trained others in surveying common household breeding sites of mosquitoes. Possible breeding sites of mosquitoes included drinking water containers, used water containers, water containers in the bathroom and toilet, cupboard saucers in the kitchen, vases, plants-related containers and discarded containers surrounding the household.

Data analysis

An assessment of the larval indices surveillance system was performed using the results from the system. This involved analysis of the larval indices using the computer program at <http://lim.wu.ac.th>. Larval indices were analyzed to assess the ratio of the HI, CI and the BI levels. The types of containers were recorded to assess frequency and percentage. Pre- and post-development systems were performed assessing the VHVs' dengue knowledge and larval indices understanding and then analyzed with descriptive statistics. The testing difference of the hypothesis of equivalency proportions (null hypothesis: H_0) and non-equivalently proportions (alternative hypothesis: H_1) of the frequency of correct items before and after using the surveillance system and between low and high risk PCUs were analyzed with a χ^2 test and Fischer's exact test. The comparison mean of total VHV's dengue knowledge score before and after using the surveillance system, and between low and high dengue risk PCUs were analyzed with a t -test statistic. The steps of developing active surveillance systems were summarized with a diagram.

Results

The Aedes larval indices surveillance system of low and high risk PCUs

The low and high dengue risk PCU system for active surveillance of larval indices consisted of seven steps: first, VHVs were responsible for 10–15 households/VHV and divided into 2–5 groups per village (total 22 groups per 6 villages in low dengue risk PCUs, and 20 groups per 4 villages in high dengue risk PCUs) in order to support householders to optimize their survey of larval indices every seven days. Second, the VHVs surveyed the larval indices in a "violet book" survey every 25th day of the month and sent larval indices data to the group leader. Third, the

group leader collected data from the VHVs in a “blue book” every 28th day of the month. Fourth, the village leader collected the total data from groups in a “yellow book” that were in turn sent to the PCU. Fifth, the designated PCU official was responsible for collecting and recording data from all villages into the online program at <http://lim.wu.ac.th>. The program analyzed and reported larval indices levels on the 30th of the month. Sixth, Both PCU officials would report and communicate the larval indices level (BI, HI and CI) at the VHV’s meeting on the 9th of the following month. The health worker proposed levels of larval indices as information for all VHVs in order to prevent dengue in high dengue risk villages, and seventh, the VHVs and the head official of the PCU were responsible for communicating information to all stakeholders in the community such, as LAOs, primary schools and households (Figure 1).

The high dengue risk PCU focused only on the seven steps in the standard surveillance system, with no further proactivity in the four villages. In contrast, the low dengue risk PCU showed the best practice of activity by making the most of the VHVs but also, residents in the six villages came up with several activities for dengue solution that included regular inspection of household environments, use of herbal plants as mosquito repellents, sourcing fish banks for eating mosquito larvae and increased communication and education regarding dengue prevention and control. All dengue prevention activities in the six villages were an

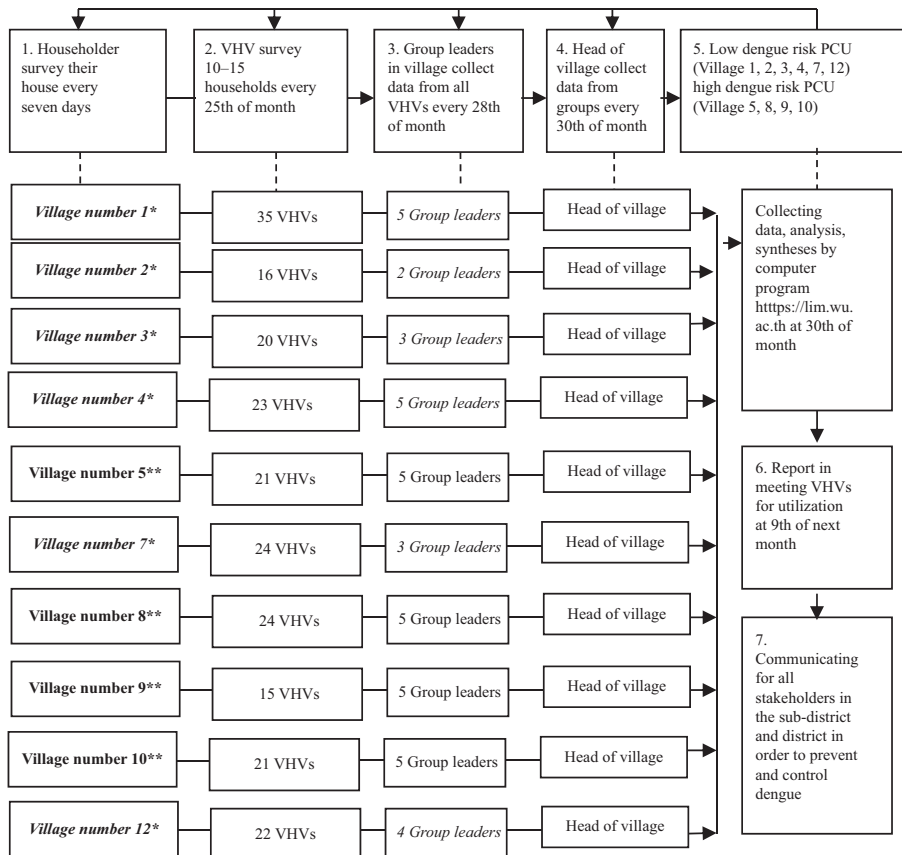


Figure 1.
The larval indices surveillance system of low and high dengue risk PCUs

Notes: *Villages number 1, 2, 3, 4, 7 and 12 were low dengue risk. ** Villages number 5, 8, 9 and 10 were high dengue risk

important component of the larval indices surveillance system in the low dengue risk PCU. Moreover, the officials of low risk PCUs were actively coordinating, teaching, coaching and supporting VHV's in all aspects of dengue prevention activities. The high dengue risk PCU showed only the seven steps of the surveillance system, but did not complete further relevant activities in each village. The results of developing the system used in this study were best practiced in the low dengue risk PCU with clear positive outcomes.

Comparison before and after implementing the system

VHV's dengue knowledge in the low and high dengue risk PCUs were assessed before and after developing the assessment system and were at ($n = 79, 69$), and ($n = 49, 47$), respectively. In the high dengue risk PCU, the dengue information sources from the household member source and television sources before and after developing the system displayed statistically different results ($p < 0.05$). However, before development, the low dengue risk PCU received dengue information more frequently than the high dengue risk PCU, whilst both PCUs received more dengue information after development. The total scores for dengue knowledge in the low and high dengue risk PCUs showed 92–100 percent of correct answers (Table II).

In total, there was no significant difference of correct answers for the VHV's dengue knowledge between the low and high dengue risk PCUs at before development ($t_{126} = 0.146$, $p > 0.05$), and after development ($t_{114} = 1.214$, $p > 0.05$). However, in the comparison before and after development, the low dengue risk PCU showed a total score (\bar{x} , SD) of correct answers before and after development, (14.67, 0.71 and 15.00, 0.00) respectively, that was significantly different ($t_{146} = -3.843$, $p < 0.001$). In comparison, the scores of the high dengue risk PCU before and after development were (\bar{x} , SD) (14.65, 0.59 and 14.98, 0.14), respectively, with a significant statistical difference ($t_{94} = -3.637$, $p < 0.001$) (Table III).

VHV's level of understanding larval indices before and after developing the surveillance system. The VHV's understanding of larval indices surveillance increased regarding items from 3 to 11 amongst the high dengue risk PCUs. Items between 1 and 10 on the other hand showed high scores before and after, and were not significantly different ($p > 0.05$). In a comparison of low and high dengue risk PCUs, the three items with no correct answers for both PCUs before development were the descriptive meaning of the BI, HI and CI indices. Item 1 was not significantly different before intervention between the PCUs. The VHV's of the low dengue risk PCU had more correct answers than the high dengue risk PCU particularly concerning the seven items before and all items after development (Table IV).

VHV's problems, barriers and need for support in low and high dengue risk PCUs. VHV's problems and barriers to achieving positive results in the low and high dengue risk PCUs were significantly different ($p < 0.01$, and $p < 0.001$ and $p < 0.05$, and $p < 0.01$, respectively). However, the larval indices survey of both PCUs were not significantly different. Additionally, results showed that the overall VHV's problems, barriers and needs support in each PCU were significantly different ($p < 0.001$, $p < 0.01$, $p < 0.001$ and $p < 0.001$, $p < 0.001$, $p < 0.001$, respectively). Thus, it was evident that both PCUs need support with the larval indices survey, with equipment for the survey, as well as increased larval indices' knowledge (Table V).

Larval indices surveillance levels and morbidity. A total of 449 households were surveyed in the ten villages including 265 houses in six villages of the low dengue risk PCU area, and 184 houses in four villages of the high dengue risk PCU. All houses were in rural communities. The participants were classified according to their sex, marital status, community status, religion, experience of dengue illness, with no significant difference in classified data results between the two PCUs. The education level, occupation, family income/month, time in the community of people in both PCUs were significantly different at $p < 0.05$, $p < 0.05$, $p < 0.01$ and $p < 0.01$, respectively. However, larval indices levels for BI, HI and CI of low and high

Table II.
VHVs' dengue knowledge before and after developing the surveillance system

VHVs' dengue knowledge	Number (percentage) of correct answers <i>n</i> (%)		χ^2	Compare low and high dengue risk PCUs Before of low and high (n = 79, 49)	χ^2	Compare low and high dengue risk PCUs After of low and high (n = 69, 47)
	Low dengue risk PCU Before (n = 79)	High dengue risk PCU After (n = 49)				
1. <i>Aedes aegypti</i> is a conductor of dengue fever	78 (98.7)	69 (100)	0.879	48 (98)	47 (100)	0.969
2. All populations in the community are at high risk of dengue fever	77 (97.5)	69 (100)	1.771	49 (100)	47 (100)	—
3. <i>Aedes aegypti</i> can fly between houses 50–100 meters away	78 (98.7)	69 (100)	0.879	49 (100)	47 (100)	—
4. A very high and sustained fever of 2–7 days is usually a sign of dengue fever	76 (96.2)	69 (100)	2.674	43 (89.6)	47 (100)	5.168
5. Dengue fever usually results in a red face and skin bleeding (arm and leg) after a fever for 2–3 days	76 (96.2)	69 (100)	2.674	46 (93.9)	47 (100)	2.970
6. Dengue treatment must follow only the signs and symptoms because no specific drug exists	73 (92.4)	69 (100)	5.462*	48 (98.0)	47 (100)	0.969
7. Patients with dengue fever can die	78 (98.7)	69 (100)	0.879	48 (98.0)	47 (100)	0.969
8. <i>Aedes aegypti</i> habitually bite during the daytime	78 (98.7)	69 (100)	0.879	49 (100)	47 (100)	—
9. <i>Aedes aegypti</i> breed in water containers that are clean, such as those in the bathroom and water jars	77 (97.5)	69 (100)	1.771	49 (100)	47 (100)	—
10. Coconut shells, broken water jars, and garbage with stagnant water surrounding the household are <i>Aedes aegypti</i> breeding sources	78 (98.7)	69 (100)	0.879	48 (98.0)	47 (100)	0.969
11. Closed water jars and water containers are a way to prevent mosquito breeding	78 (98.7)	69 (100)	0.879	49 (100)	47 (100)	—
12. Eliminate mosquito breeding sources with using clean containers and change the water every seven days	79 (100)	69 (100)	—	49 (100)	47 (100)	—
13. Dry red lime can be placed in a water container to decrease mosquito breeding	76 (97.4)	69 (100)	1.794	45 (91.8)	46 (97.9)	1.770
14. Sleep with a net to prevent mosquito bites	79 (100)	69 (100)	—	49 (100)	47 (100)	—
15. Citronella is an herb for repelling mosquitoes	79 (100)	69 (100)	—	48 (98.0)	47 (100)	0.969

Notes: Chi-square test (x2) and Fisher's Exact tests. **p* < 0.05

dengue risk PCUs were 189.4, 7.4, 1.9, and 283.4, 9.8, 5.2, respectively. All larval indices levels were higher than the Thai MOPH recommended figures.

The interviews and survey about the larval indices system showed that the low dengue risk PCU exercised better practices than the high dengue risk PCU. Examples of best practice included frequent surveys, reporting larval indices into a computer program, monitoring of household environments, rechecking the document collection system provided by health providers as well as regular reporting and data feedback to other stakeholders. In contrast, the high dengue risk PCU was only taking a larval survey once a month, and reporting data to the VHVs at their monthly meeting.

The report from the computer program “http://lim.wu.ac.th” shows the total larval indices level of BI, HI and CI in the low dengue risk PCU between August 2014 and January 2015 to be 15.99, 9.77, 1.9, and 9.21, 6.14 and 1.08, respectively, whereas the total larval indices level of the high dengue risk PCU between August 2014 and January 2015 showed BI, HI and CI to be 9.04, 8.41, 1.14, and 5.67, 4.46 and 0.73, respectively. It showed the level of larval indices of the high dengue risk to be lower than the low dengue risk PCU (Table VI). The after development showed the dengue morbidity rate to be 31 cases per 100,000 of the population, decreasing following these outbreak years, with the dengue patients staying in only the high dengue risk PCU.

Discussion

The low dengue risk PCU followed the best surveillance system practices because it had completed the seven initial steps as well as the dengue prevention activities in the six villages under its responsibility. These activities were based on the village context and worked at household level, such as checking and supervising household environments, the community level, where active communication and educational methods were practiced, as well as environmentally sustainable methods such as using herbal plants known to deter mosquitoes and increasing fish banks that consume mosquito larvae, all of which helped with improved levels of dengue prevention and control. Furthermore, the low dengue risk PCU officials strengthened each VHVs’ dengue knowledge and skills at monthly meetings. The high dengue risk PCU on the other hand conducted only the seven steps as a basic requirement as they lacked support and involvement of the PCU officials and the head of the VHVs of the four villages. Successful resolution of the dengue problem needs community involvement by all stakeholders for the success of the community participatory action research used in this study[20]. This requires combined efforts in implementing the new larval indices surveillance system, auctioning the dengue prevention strategy of the WHO that encourages a proactive surveillance system, use of the computer program as well as encouraging community action[15, 21].

VHVs’ dengue knowledge	Before development of low and high dengue risk PCUs (<i>n</i> = 79, 49)			After development of low and high dengue risk PCUs (<i>n</i> = 69, 47)			Before and after development of dengue risk PCUs	
	\bar{x} (SD)	Mean difference	<i>t</i> -test	\bar{x} (SD)	Mean difference	<i>t</i> -test	Mean difference	<i>t</i> -test
Low dengue risk PCU	14.67 (71)	0.18	0.146 ^{ns}	15.00 (0.00)	0.21	1.214 ^{ns}	-0.329	-3.843***
High dengue risk PCU	14.65 (0.59)			14.98 (0.14)			-0.326	-3.637***

Notes: ^{ns}No significant. Independent *t*-test statistic significant. ****p* < 0.001

Table III.
The total scores of VHV’s correct answers regarding dengue knowledge before and after developing the surveillance system in low and high dengue risk PCUs

Table IV.
Understanding larval indices of low and high dengue risk PCUs

Understanding larval indices	Number (percentage) of correct answers $n(\%)$						χ^2	
	Low dengue risk PCU		High dengue risk PCU		Low and high dengue risk PCUs		Before	After
	Before ($n = 79$)	After ($n = 69$)	Before ($n = 49$)	After ($n = 41$)	Before ($n = 79/49$)	After ($n = 69/41$)	χ^2	χ^2
1. Identify the important larval indices for dengue prevention	66 (83.5)	65 (95.6)	40 (81.6)	31 (75.6)	0.162	9.719**	1.665	112.171***
2. Identify the significant types of larval indices	74 (93.7)	66 (97.1)	0	28 (68.3)	55.012***	18.403***	55.012***	0
3. Descriptive meaning of larval index BI	0	68 (100.0)	0	28 (68.3)	49.538***	24.481***	49.538***	0
4. Descriptive meaning of larval index HI	0	68 (100.0)	0	26 (63.4)	45.926***	28.848***	45.926***	0
5. Descriptive meaning of larval index CI	0	68 (100.0)	0	24 (58.9)	41.752***	33.405***	41.752***	0
6. Identify the result of calculating index BI	42 (53.2)	64 (94.1)	0	11 (26.8.0)	34.640***	56.823***	34.640***	84.926***
7. Identify the result of calculating index HI	58 (73.4)	67 (98.5)	0	9 (22.0)	25.286***	71.401***	25.286***	85.196***
8. Identify the result of calculating index CI	64 (81.0)	67 (98.5)	0	9 (22.0)	25.286***	71.401***	25.286***	85.196***
9. Conducting activities' prevention when found larval breeding in and out household	5 (6.3)	68 (100.0)	21 (42.9)	30 (73.2)	8.683*	20.292***	8.683*	69.603***
10. PCU reported larval indices to all stakeholders in community	64 (81.1)	67 (98.5)	24 (49.0)	28 (68.3)	6.590	20.913***	6.590	14.738***
11. Utilities of using larval indices survey	7 (8.9)	66 (97.1)	2 (4.1)	7 (17.1)	48.541***	74.008***	48.541***	6.415*

Notes: χ^2 and Fisher's exact tests. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

VHV's problems, barriers, and needs support	Number (percentage) $n(\%)$						χ^2		Active larval indices surveillance system
	Low dengue risk PCU			High dengue risk PCU			Low and high dengue risk PCUs		
	Before ($n = 79$)	After ($n = 69$)	χ^2	Before ($n = 49$)	After ($n = 41$)	χ^2	Before ($n = 79,49$)	After ($n = 69,41$)	
1. Have problems with larval indices survey	2 (2.5)	12 (17.6)	10.280**	14 (28.6)	5 (12.2)	8.144*	31.896***	24.104***	417
2. Barrier of identify and calculation of larval indices	36 (45.6)	5 (7.4)	38.607***	17 (34.7)	7 (17.1)	13.021**	13.254**	56.220***	
3. Need support with the larval indices survey	33 (41.8)	34 (50.0)	2.904	15 (30.6)	5 (25.0)	5.347	21.561***	44.230***	

Notes: χ^2 and Fisher's exact tests. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table V.
VHV's problems, barriers and needs support in low and high dengue risk PCUs

Larval indices level	Low dengue risk PCU ($n = 265$)		High dengue risk PCU ($n = 184$)		Larval indices level of before and after development system in low and high dengue risk PCUs
	Before (August, 2014)	After (January, 2015)	Before (August, 2014)	After (January, 2015)	
BI (BI < 50)	15.99	9.21	9.04	1.14	
HI (HI < 10)	9.77	6.14	8.41	5.67	
CI (CI < 1)	1.9	1.08	1.14	0.73	

Table VI.
Larval indices level of before and after development system in low and high dengue risk PCUs

The VHVs knowledge of dengue (15 items) was very good, but their larval indices knowledge and skills were poor. The new larval indices surveillance system was found to be an important active strategy for community-based dengue solutions[1, 22]. Comparing the results after development showed an increase in dengue knowledge, and larval indices. The group leaders were important key groups to survey mosquito breeding and communicate larval indices to other stakeholders. The practical work in the Thai MOPH System was carried out by the PCU and VHVs who worked with dengue prevention and control in the community who were responsible for associating the previous studies carried out in southern Thailand[12], and other areas[6]. The VHVs dengue knowledge was good, but the understanding larval indices levels of knowledge were very poor. Thus, an education program was needed to integrate a larval indices management system because it increased the effectiveness of the vector control program [7, 23]. Moreover, the dengue morbidity rates after the intervention were zero in the low dengue risk PCU because the VHVs and community were clear concerning the larval indices surveillance system.

The household environment and larval indices survey of 449 households in the low dengue risk PCUs (265 households in six villages) and high dengue risk PCUs (184 households in four villages) showed that all levels of larval indices were higher than the standard level of the Thai MOPH recommendations both before and after developing the system. Evidence from the dengue risk assessment criteria in each village showed that high risks for dengue transmission was due to these areas being tourist sites, villages with higher rates of agricultural workers, reduced or no water, as well as several water containers left inside and outside the house that were associated with a high dengue illness rates compared to five years before[24]. This indicated that the dengue problem is being exacerbated by

eco-bio-sociologic factors[6]. However, both PCUs have now tried to develop the larval indices surveillance system, with VHVs awaiting instruction from PCU officials before commencing dengue prevention activities.

The larval indices knowledge levels of the low dengue risk PCU were higher than the high dengue risk PCU. It is possible that the VHVs in the low dengue risk PCU have a better understanding of larval indices than high dengue risk PCUs based on suggestions from systematic review studies indicating that the knowledge of vector ecology was required for resolving the dengue problem[25]. VHVs should be better educated about dengue and better understand larval indices that will help them to support prevention methods. Additionally, they should be trained to monitor the new system so it becomes a sustainable solution to the dengue problem. For example, a survey of household environments every seven days, on the 25th of each month with this practice continued for a period from three to seven years[15, 26]. The larval indices surveillance system is good but VHVs need to strengthen their capabilities in terms of knowledge and skills as specified in the larval indices survey.

Conclusion

The “Apply CPAR approach” on the five phases of this assessment consisted of all stakeholders in the sub-district and included health providers in low and high dengue risk PCUs, VHVs, householders in ten villages and others. VHVs were in under a PCU responsible for six low dengue risk villages and four villages in the high dengue risk PCU. They were available for participation in the study phases, such as community participation, situation analysis, planning, development and evaluation of the surveillance system. The results of the test before intervention showed that the basic dengue knowledge of the VHVs was good but they had a poor knowledge of larval indices. However, all VHVs in both PCUs had an increased understanding of larval indices after intervention, because the intervention program developed their knowledge and skills on the topic. The comparison outcomes between before and after intervention showed that almost all items of larval indices and activities of larval surveillance of the VHVs had increased. However, the active surveillance of larval indices remains an important consideration in the prevention of dengue in low and high dengue risk PCUs. Moreover, all VHVs require the support of the PCU officials for coordinating, teaching, coaching and conducting the dengue projects in the villages under their remit.

Limitations

There are some limitations to our study. First, we identified the criteria of the village level assessment of dengue risks and related factors for dengue to emerge. Second, the study areas focused on the villages in the low and high dengue risk PCUs only. Third, VHVs in both PCUs participated as the volunteers because the success of the CPAR concept needs the participant’s agreement and participation.

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