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Children's basic knowledge and activities for dengue problem solution: an islamic religious school, Southern Thailand

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ABSTRACT

Objective: To develop children's basic knowledge and activities to solve the dengue problem, and to evaluate the results from children's activities. **Methods:** Participatory Action Research (PAR) was applied in five steps: 1) preparation step; 2) assessment step; 3) children's activities planning step; 4) implementation step; 5) evaluation step. Basic knowledge of dengue was evaluated by questionnaires (17 items) and analysis pre and post-activities by a Chi-square statistic test. The children's understanding of the dengue problem was evaluated by drawing pictures and participation of children's activities. Larval Indices (BI, HI, and CI) were ratio analysis which related dengue outbreak measurement. **Results:** Three groups for children's activities were: 1) group leaders (13 children); 2) general children; 3) a support group from the community. "Education of dengue learning", "dengue prevention campaign", and "the recycle garbage bank" were core children's activities. Most children's knowledge question items showed an increase from pre-activities to post-activities, and a half of all questions items were statistically significantly different ($P < 0.05$). There were five categories of children's reflection from the drawn picture that showed understanding of the solution to dengue problems and methods for eliminating sites of mosquito breeding in the community. Their households had increased garbage management, and thus decreased numbers of mosquito breeding types such as larval indices (BI, HI, and CI) which decreased from before the activities (93, 30, and 14) to after them (7, 5, and 1). Furthermore, no instances of dengue morbidity or the mortality rate occurred during the study. **Conclusions:** Although there was an increase in the children's knowledge and activities, and a decrease in larval indices ratio, the high risk of a dengue epidemic might be found because the ratios of larval indices were based on community's behaviors. Thus, it is essential for children and all stakeholders in and out of the community needed to better combat the dengue problem.

1. Introduction

Dengue is one of the most important arthropod-borne viral infections affecting humans. Worldwide, an estimated 2.5 billion people are at risk of infection, approximately 975 million of whom live in urban and rural areas in tropical and sub-tropical countries^[1]. In Thailand, dengue has been a significant public health problem for the past fifty years. Although the mortality rate has decreased in hospitals, the morbidity rate has unfortunately increased in all areas from 1998 to 2009. The southern area, especially, has higher dengue incidence than other areas, possibly due to factors

such as a greater number of rainy days, more rainfall, higher relative humidity, and a warmer temperature^[2]. Southern Thailand has a dengue problem because the high morbidity rate and high larval indices.

Nakhon Si Thammarat is one of the fourteen provinces in Southern Thailand with several high risk dengue communities. The Islamic community studied consisted of 128 households in 600 square meters. The locations of the houses in the community were semi-urban, closed households, low socioeconomics (mean 5 124.35 baht/month), and almost all were laborers and fisherman. The population in the community was 733, consisting of 357 males, 376 females which was divided into the following age groups: 0–5 years (36 people), 6–12 years (113 people), 15–20 years (73 people), 21–40 years (239 people), 41–60 years (192 people), and more than 60 years (80 people). Thus, most of the populations were children. In the past years, two children

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had dengue, the morbidity rate of dengue in October, 2009 to September, 2010 was 638 per 100000 people and higher than the Thai Ministry of Public Health's disease standard (<20 per 100000 populations). Although, there were no instances of mortality during this time, the morbidity showed that the area was at risk of a dengue epidemic. Moreover, the larval indices (BI: 74, HI: 22, and CI: 12) of the community were higher than the standard (BI<50, HI<10, and CI<1). These indexes were strongly positively correlated with epidemic and transmission intensity^{3, 4}.

There were 80 children studying at the Islamic religious school in the community which opened every Saturday and Sunday and teaching Islamic ideals such as the Islamic legal code, role and function of the Muslim people, and the major activities of Muslims. Their age was 7–15 years. All stakeholders in the community and the children group leaders met and concluded that children's activities were needed for solving the dengue problem because dengue morbidity was found for two children in the school. Previous studies have shown that school-based education and activities are an important compliment to increasing children's knowledge of and participation in the dengue problem solution^{5–8}. Thus, the present study aims to develop children's basic knowledge and activities for addressing the dengue problem, and to evaluate the results from children activities.

2. Materials and methods

The study was a part of the eradication of *Aedes aegypti* sources through dengue prevention and control in an Islamic community, in the southern region of Thailand. Participatory Action Research (PAR) was applied in this study. The study was received and forwarded to the International Review Board (IRB), the Ethical Review Committee for Research Subjects, the Health Science Group, Walailak University, Thailand.

2.1. Study area and participants

The study took place between November, 2010 and June, 2011, in a Saturday and Sunday Islamic religious school, Southern region, Thailand. The school has a traditional Islamic education program for 80 children, three Islamic religious teachers and ten Muslim religious leaders. The participants of study for development of knowledge and activities were children and their households for larval indices survey.

2.2. Methods

Participatory Action Research (PAR) was applied to five steps: 1) preparation step; 2) assessment step; 3) developing strategies planning step; 4) implementation step; and 5) evaluation step.

2.2.1. Preparation step

The principle researcher discussed with representatives of all stakeholders the dengue problem in the Muslim community such as community leaders, Islamic religion teachers, religious leaders, the district administrative organization, primary health care station and the children's parents. The meeting concluded that children in the school had a high dengue morbidity rate related to high levels of larval indices in the community and a high risk of dengue transmission⁹.

2.2.2. Assessment step

The assessment step consisted of situation assessment and re-assessment of the children's basic knowledge and the results of children's activities. The situation assessment used qualitative methods by the researcher such as leader group discussions, and environmental surveys. This phase was selected in order to better understand the diversity of the dengue problem. Basic knowledge of dengue was assessed by researcher. The assessment consisted of: 1) leaders group discussions, volunteer children met to discuss at least once a month to assess, plan, implement and re-assess; 2) larval indices survey in children's household community; and 3) dengue mortality and morbidity monitor from the primary health center. The researcher provided the objectives of the study, obtained informed consent, discussed the focus group process, and obtained permission to audio record the session. To foster a flexible climate for discussion, the conversations were held in the local language, and lasted between 30 to 45 min per meeting.

2.2.3. Developing children's strategies planning step

This step followed the preparation and assessment steps. The researcher, supportive group, and the group leader of the children were discussing techniques and methods of analysis of the dengue problem to find solutions in school over a six month period.

2.2.4. Implement step

The basic strategies for dengue prevention and control were engaging together in activities within children, leader and non-leader groups. The study built abilities through training, group discussions and consensus, promotional campaigns, and operational meetings once a month. The large meetings of all the children were participatory and created several plans for dengue solutions from the beginning until the end of intervention.

2.2.5. Evaluate step

Leader and support groups presented the process and outcomes of the study for all children in the school. The process and outcomes would encourage routine activities for dengue prevention and control in an Islamic school. The main activities of the step were the re-assessment step centred on assessing the outcomes. The step was a feedback step for others steps such as the assessment, plan, implementation, and comparison before and after

conducting the activities. The meetings were structured as a series of workshops attended by the researcher, and the support group who were involved in dengue prevention and control in the school.

2.3. Measurements

The results were measured, before and after the activities, by qualitative and quantitative collecting data methods. The children's basic knowledge was reported by questionnaires, larval indices for children's households surveyed, and morbidity and mortality rate reported by the primary health center station.

2.3.1. Children's basic knowledge of dengue

The questionnaires were developed and tested by the researcher. The format of the self-report of basic knowledge consisted of two parts: Part I: general characteristics, Part II: children's basic knowledge. The content validity by three experts in dengue prevention and control and reliability was testing with 30 children and analyzed by Alpha's conbrach 0.83. The survey was 15 min long and consisted of 17 items on dengue knowledge divided into three categories in each item: yes, no and unknown. Basic knowledge questions were distributed into topics on the cause of dengue, major signs of dengue, mosquito-bite prevention, dangers of dengue, mosquito life cycle, methods for mosquito elimination, and garbage management.

2.3.1.1 Participants and sample size of children's knowledge

The responsible parties for dengue prevention and control intervention in the communities were leaders and non-leaders^[10–12]. In the study, all children (the leader's group and general children) were selected for assessment and re-assessment. They were representatives of households in the community.

2.3.1.2 Data collection

The researcher introduced herself and presented the objectives of the study to the community, children's parents and the representatives of organizations in the community. Next, they obtained consent from children's parents at the first session and began collecting data.

2.3.2. Larval indices survey

Standard larval index surveys as epidemiological indicators of dengue transmission should be viewed with caution^[13]. The three traditional larval indices were: the House Index (HI)—the percentage of houses infested with larvae and/or pupae; the Container Index (CI)—the percentage of water-holding containers infested with larvae and/or pupae; and the Breteau Index (BI)—the number of positive containers per 100 houses inspected. Additionally, these were compared pre and post-activities building community capacity for combating dengue^[11,14]. Sample size, in an entomological survey involving a large community of more than 300 households, a sample size of approximately 10%, or

at least 100 households, should be taken^[11]. In this study, the water in more than 100 households was surveyed. The supportive group collected data for the larval indices survey. The principle researcher then analyzed and reported this to the student leader team for planning and discussion.

2.3.3. Dengue morbidity and motility rate monitoring

Dengue is a complex problem because it involves entomology, epidemiology, and socio-ecological components. Therefore, secondary data collection for the communities involved rates of dengue incidence.

2.4. Data analysis

2.4.1. The process of development of children's knowledge and activities

The process of development of children's knowledge and activities were reported by qualitative data such as the type of activities.

2.4.2. Children's basic knowledge

Children's basic knowledge of dengue was compared pre and post-activities such as: 1) Personal information of the participants was collated by descriptive statistics, percentage, mean, and standard deviation; 2) Basic knowledge of dengue was analyzed with descriptive statistics. The correct answer in each item was analyzed with frequency and percentage, and compared with the correct answer percentage both pre and post-activities by the Chi-squared (χ^2) tests at a 0.05 level of statistical significance.

2.4.3. Larval indices

Larval indices were analyzed ratio as the House Index (HI)—the percentage of houses infested with larvae and/or pupae; the Container Index (CI)—the percentage of water-holding containers infested with larvae and/or pupae; and the Breteau Index (BI)—the number of positive containers per 100 houses inspected. The types of containers were computed with frequency and percentage.

2.4.4. Dengue morbidity and mortality

Morbidity and mortality rates of dengue in children in the community were analyzed based on information from the health care center station in the communities.

3. Results

The results were based on the context of the community and participation of all groups. This study focused on three main results: the children's activities group, the children's activities for talking the dengue problem, and the results from these activities.

3.1. Children's activities group

There were three volunteer groups for conducting activities

Table 1
Percentage of characteristics in pre and post- activities.

Characteristics	Percentage (%)	
	Pre-activities (n=79)	Post-activities (n=59)
Gender ^{NS}		
Boy	51	47
Girl	49	53
Age*		
< 9 years	29	12
9-12 years	56	71
> 12 years	15	17
Education level**		
Basic Primary education level 1	21	0
Basic Primary education level 2	27	29
Basic Primary education level 3	15	25
Basic Primary education level 4	17	14
Primary education level 5	8	12
Primary education level 6	11	17
Secondary education level 1	1	3
Family occupation ^{NS}		
Laborer	37	39
Farmer	3	3
Fisherman	19	22
Businessman	34	32
Government officer	5	2
Housewife	1	2
No occupation	1	0

Chi-squared (χ^2) statistic: ** $P < 0.05$; * $P < 0.01$; ^{NS}=Non Significant.

Table 2
Comparison percentage (%) between pre and post-activities that received sources of dengue Information.

Sources of dengue information	Percentage (%)	
	Pre-activities (n=79)	Post-activities (n=59)
Family*	57	63
Neighborhood*	29	58
Village health volunteer*	58	64
Health provider*	42	46
Information dome of Mosque*	14	44
Television*	56	56
Teacher at the school*	35	36
Community dengue project*	39	58

Chi-squared (χ^2) statistic: * $P < 0.001$.

**Figure 1.** Teaching about dengue in the classroom of the Islamic religious school.**Figure 2.** Children participating with the community in campaigning to eliminate garbage.

Table 3
Children's basic knowledge of correct (%) between pre and post-activities.

Children's basic knowledge	Correct (%)	
	Pre-activities	Post-activities
1. <i>Aedes aegypti</i> is a conductor of dengue fever ^{NS}	97.5	96.6
2. A high risk of dengue fever will occur in all populations in the community ^{NS *}	84.8	93.2
3. <i>Aedes aegypti</i> can fly from house to another house 50–100 meters away [*]	59.5	96.6
4. Very high and sustained fever 2–7 days is usually a sign of dengue fever ^{**}	72.2	93.2
5. Dengue fever usually results in a red face and skin bleeding (arm and leg) after a fever for 2–3 days ^{**}	69.6	94.9
6. Dengue treatment must follow only the signs and symptoms because there is no specific drug [*]	53.2	93.2
7. Patients with dengue fever may die ^{**}	81.0	94.9
8. <i>Aedes aegypti</i> habitually bite in the day time ^{**}	70.9	88.1
9. <i>Aedes aegypti</i> like breeding in water containers which are clean such as water containers in the bathroom and water jars ^{NS}	94.9	100.0
10. Coconut shells, broken water jars, and garbage with stagnated water surrounding the household are <i>Aedes aegypti</i> breeding sources ^{NS}	97.5	100.0
11. Closed water jars and water containers are a method to prevent mosquito breeding [*]	97.5	100.0
12. Eliminate mosquito breeding sources with clean container and change the water every 7 days ^{NS}	93.7	96.6
13. Dry red lime can be in water container to decrease mosquito breeding [*]	73.4	96.6
14. Sleep in a net to prevent mosquito bites ^{NS}	91.1	96.6
15. Cytronella is herb for expelling mosquitos ^{NS *}	97.5	96.6
16. Managing garbage in your house can prevent dengue fever ^{NS}	57.0	44.1
17. A recycling garbage bank can eliminate mosquito breeding sources [*]	72.2	100.0

Chi-squared (χ^2) statistic: * $P < 0.05$; ** $P < 0.001$; ^{NS}=Non Significant; ^{NS *}=Non Significant and decreased in post-activities.

Table 4
Type of garbage, percentage of garbage management (%) between pre and post-activities.

Type of garbage	Percentage of garbage management (%)	
	Pre-activities	Post-activities
	November, 2010 (n=79)	June, 2011 (n=59)
Paper garbage	18.2	77.8
Food garbage	72.7	100.0
Plastic garbage	72.7	98.1
Glass bottle garbage	85.5	100.0
Garbage surrounding household	67.3	87.7

Table 5
Percentage of larval indices (%) between pre and post- activities.

Larval indices (percentage)	Percentage of larval indices (%)	
	Pre-activities (n=79)	Post-activities (n=59)
	November, 2010	June, 2011
BI (<50)	93	7
HI (<10)	30	5
CI (<1)	14	1

Table 6
Types of containers, number of inspected, positive containers, percentage of positive containers per container inspected between pre and post-activities.

Types of containers	Number of inspected: positive containers: percentage of positive containers per container inspected (n: n: %)	
	Pre-activities (n=79)	Post-activities (n=59)
	November, 2010	June, 2011
1. Drinking water containers	175:34:19	125:4:3
2. Used water containers	117:10:9	94:4:3
3. Water containers in the bathroom and toilet	87:16:18	60:0:0
4. Cupboard saucers	13:0:0	5:0:0
5. Vases	3:0:0	0:0:0
6. Plants-related containers	56:0:0	105:0:0
7. Discarded containers surrounding the household	12:4:33	0:0:0
Total	463:64:14	389:4:1

of children: 1) the leader group was composed of 13 volunteer children involved with the active prevention and control of dengue activities; 2) the non-leader group consisted of general children who were involved in activities after receiving and promoting dengue problem solution strategies. The leader group of children was well trained in recycle garbage bank management such as process conduction, data collection and knowledge of garbage types by researcher; and 3) the support group consisted of ten community leaders such as a health worker representatives from the primary health care station who was involved with providing dengue solutions to the school and communities, local administrative officers, a community leader, three teachers

and the people in community. The support group's role was supporting and facilitating activities for building student's capacity, such as meeting with and training the leader group to increase their knowledge of dengue. The meeting among three groups and people in the community for monitoring and evaluating children's activities with reference to dengue were held once a month.

3.2. The children's activities for dengue problem solution

The children's activities for dengue problem solutions were "learning basic knowledge of dengue", "dengue prevention campaign", and "the recycle garbage bank".



Figure 3. The recycle garbage bank of the Islamic religious school at the Mosque in the center of community.

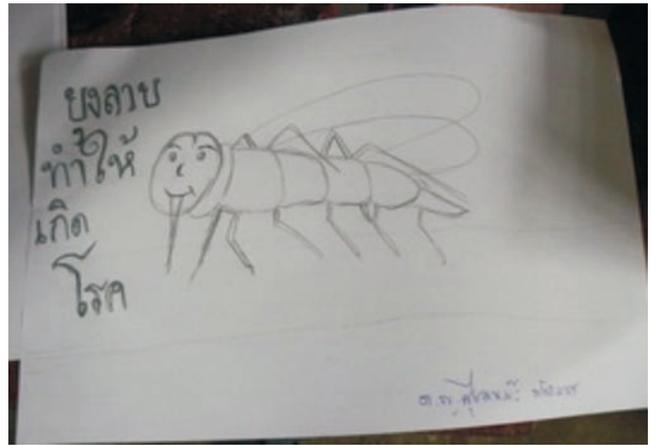


Figure 5. A picture showing mosquitos with the words dengue disease.



Figure 4. Book bank for recording the amount of garbage.



Figure 6. Sweeping up garbage in and around the household.

3.2.1 Learning basic knowledge of dengue

The program of education consisted of four sections: 1) Dengue knowledge was taught by the principle researcher, it was addressed using questions following the tested items then answered. There were empowerments of the children who gave the correct answer with rewards. The principle researcher explained and gave examples to aid clear understanding; and 2) Posters for dengue knowledge communication, posters showing the signs and symptoms of dengue fever, activities for dengue prevention and control and activities of the recycle garbage bank (Figure 1).

3.2.2 Dengue prevention campaign

A campaign to promote garbage elimination was held once a month to aid in dengue control. The youth group (leader group, general youth group), the support group, and people in the community participated in encouraging the community to tackle dengue. They were happy and enjoyed themselves when they joined the activity, 30-40 children/time (Figure 2).

3.2.3 The recycle garbage bank

The principle researcher also demonstrated ways

to eliminate garbage in the community. The support group demonstrated type of garbage, method of garbage elimination, and putting the right type of garbage in the right garbage bin. The leader group of children conducted garbage bank activities such as: 1) having the large garbage bin for stocking and dividing recycleable garbage at the bank; 2) setting up a child committee for running activities at the bank such as a selection garbage person, account, and advertisement of the recycle garbage bank's activities; 3) receiving garbage every Sunday by using the garbage bank book; 4) collecting the total recycled garbage for buying once a month; and 5) giving reward as a bonus for children who can recycle more garbage. All activities of recycle garbage bank were monitored by the support group (Figure 3 and Figure 4).

3.3. The results from the children's activities

3.3.1 The level of children's basic knowledge

The basic knowledge of pre and post-activities was evaluated by 17 questions. The results were divided into two sections: personal information, and basic knowledge of the children.

3.3.1.1 Personal information

There were 79 children in pre-activities and 59 children in post-activities. The two sexes (boy and girl) were nearly equally divided in the pre and post-activities. Most of the children in both groups (pre and post-activities) were aged 9–12 years old (56%:71%), their education level was basic primary education 1–4 (80%:68%) and the most common occupation of the family was that of a laborer (37%:39%). When the pre and post-activities groups were compared on these demographic variables using the chi-square (χ^2) test, they were not significantly different for gender and family occupation except for age and education level ($P < 0.05$) because the study was conducted for more than 6 months resulting in a consequent change in educational level. Thus, some of the children became older and their educational level changed later in the experiment. The test was essential for the next χ^2 -tests of dengue knowledge between the two groups, since the demographic variables in the study could affect the output variable (Table 1).

3.3.1.2 Dengue from sources information

Children were increasing knowledge regarding dengue from sources information from pre-activities group ($n=79$) to post-activities group ($n=59$) and statistically significant different (χ^2 -test) such as: family (57% to 63%; $\chi^2=55.038$; $P < 0.001$); Neighborhood (29% to 58%; $\chi^2=78.017$; $P < 0.001$); Village health volunteer (58% to 64%; $\chi^2=52.986$; $P < 0.001$); Health provider (42% to 46%; $\chi^2=78.583$; $P < 0.001$); Information dome of Mosque (14% to 44%; $\chi^2=106.066$; $P < 0.001$); Television (56% to 56%; $\chi^2=60.953$; $P < 0.001$); and Teacher at the school (35% to 36%; $\chi^2=88.98$; $P < 0.001$) (Table 2).

3.3.1.3 Children's basic knowledge

Almost all the post-activities, children correctly answered the questions, a statistics significant increasing (χ^2 test). The

test significance between pre and post-activities were two groups of children' answered. There four question's numbers were statistically significant difference of correct answers in pre and post-activities such as number 4 "Very high and sustained fever 2–7 days is usually a sign of dengue fever" (59.5% to 96.6%; $\chi^2=22.387$; $P < 0.001$); number 5 "Dengue fever usually results in a red face and skin bleeding (arm and leg) after a fever for 2–3 days" (69.6% to 94.9%; $\chi^2=8.109$; $P=0.004$); number 7 "Patients with dengue fever may die" (81% to 94.9%; $\chi^2=5.756$; $P=0.016$), and number 8 "*Aedes aegypti* habitually bite in the day time" (70.9% to 88.1%; $\chi^2=5.907$; $P=0.021$). There were four question's numbers were begin more statistically significantly difference such as number 3 "*Aedes aegypti* can fly from house to another house 50–100 meters away" (59.5% to 96.6%; $\chi^2=22.387$; $P < 0.001$); number 6 "Dengue treatment must follow only the signs and symptoms because there is no specific drug" (53.2% to 93.2%; $\chi^2=25.950$; $P < 0.001$); number 13 "Dry red lime can be in water container to decrease mosquito breeding" (73.4% to 96.6%; $\chi^2=13.08$; $P < 0.001$); and number 17 "A recycling garbage bank can eliminate mosquito breeding sources" (72.2% to 100%; $\chi^2=19.546$; $P < 0.001$). Whereas, the question's number 1, 2, 9, 10, 11, 12, 14, 15, and 16 were non statistic significantly different in pre and post-activities. There were two questions which decreased post-activities specifically question number 1 and 16; "*Aedes aegypti* is a conductor of dengue fever" (97.5% to 96.9%; $\chi^2=0.088$; $P=0.76$); and "Managing garbage in your house can prevent dengue fever" (57% to 44.1%; $\chi^2=2.248$; $P=0.169$) (Table 3).

3.3.2 Children's reflection by draw picture

Drawing a simple picture was an activity for determining the children's perceptions of dengue. There were 59 children's drawing of dengue knowledge which may be split into five categories: 1) characteristics of the mosquito such as an adolescent mosquito; 2) nature of dengue fever such as signs and symptoms; 3) sources of mosquito breeding such as plastic garbage, bottles, and unused containers surrounding the household; 4) methods of eliminating garbage which are sources of mosquito breeding, such as sweep garbage out of the household and the surrounding area; and 5) participating in a campaign for eliminating garbage (Figure 5 and Figure 6).

3.3.3 Garbage management activities

Garbage management activities in the children's households were the indirect outcome of the study. According to the recycle garbage bank, children and their parents learnt garbage management such as garbage selection into separate garbage bin; their parents supported collecting the garbage and helped children to set up the recycle garbage bank, decreasing garbage in household because the garbage was sent to the recycle garbage bank every Sunday. The survey of garbage in the children households showed frequency and percentage of post-activities increased compared with pre-activities such as paper (18.2%:77.8%), food garbage (72.7%:100%), plastic (72.7%:98.1%), glass bottles (85.5%:100%), garbage surrounding the household (67.3%:87.7%) (Table 4).

3.3.4 Larval index on pre and post-activities

Larval surveys were conducted to determine types of containers and larval indices in community. The pre-activities survey was conducted on November, 2010 (79 households), after these after an intervention of 6 months the post-activities survey was done during June, 2011 (59 households). The BI, HI, and CI in the pre and post-activities in the community were 93, 30, and 14, and decreased to 7, 5, and 1 in the post-activities (Table 5).

3.3.5 Type of water container between pre and post-activities

Types of water container inspected showed from the larval survey seven types of water containers observed during the pre-intervention (November, 2010) and post-activities (June, 2011) were 463 and 389 pieces respectively. The percentage of positive containers per container inspected pre-activities showed a very high percentage of positive containers being discarded containers surrounding the household 64% decreasing to 4% post-activities. The percentage of positive containers per container post-activities decreased from pre-activities. Though the number of discarded containers surrounding households was less the number of container inspected pre-activities (33%) but the percentage of positive containers per number inspected was not observed post-activities. In conclusion, the total percentage change for percentage of positive containers per container inspected in the post-activities decreased (from 14% to 1 %) (Table 6).

3.3.6 Dengue morbidity and mortality rate

The epidemiological index in this study consisted of the morbidity and mortality rates. The comparison of morbidity rate of dengue pre-activities were 675 per 100 000 populations, but during and post-activities in the study (November, 2010 to September, 2011) there was no presentation of morbidity and motility rate in the community reported by primary health care center station.

4. Discussions

An Islamic religious school was the center of the Muslim community. Children stayed in the community with their family. Although, the community has a city water supply and garbage disposal, the community land was plain with no ditches for releasing water when there's heavy rain. There had been a lack of garbage management in the community most people usually discard garbage into the canal and public area, and surrounding household. Their households were closed buildings. The community had a low socioeconomic population (mean 5 124.35 baht/month) because their occupations were laborers and fisherman. According to the above reasons, the community had a high risk of dengue^[14] (morbidity rate 638/100 000 population). Although there were no reported deaths due to dengue the morbidity rate of community in 2010 were higher than 20/100 000 population which Thai Ministry of Public Health index. The morbidity rate was associated with HI (30%) reflecting female *Aedes aegypti* 500 000 mosquitoes/km²

which results in a high risk of a dengue epidemic^[14]. The first survey of the study found several sources of mosquito breeding in the community such as discarded containers (33%), drinking water containers (19%), and water containers in the bathroom and toilet (18%) associated with previous studies about water containers breeding sites^[15,16].

The children's activities for dengue problem solutions in the study (education program, dengue prevention campaign, and recycle garbage bank) were based on the context of the religious school (children, teachers, and religious leaders) and the community (community leaders, parents of children, and stakeholders). The participatory approaches in five steps were preparing all stakeholders to find the ideas for solving the dengue problem, meeting for planning, conducting the activities, and evaluation. The results of the study showed improvement in children's knowledge, ability to draw pictures, garbage management, larval indices, and dengue morbidity rate because the stakeholders were supporting such as their parents, teachers, and community leaders. These process and the results of the study confirmed the concept of community participatory action which increased community capacity for tackling dengue^[17,18].

The basic knowledge and activities of children in the study were followed with the community survey and dengue knowledge of the children in pre-activities participating in the support group (one researcher, health care provider, health village volunteer, community leader, and teacher). The support group was an important group for enhancing children's activities. For the planning and implement phases, children participated in group discussion for setting up the recycle garbage bank, dengue knowledge training, and a campaign for promoting solutions to dengue as core activities for the children^[8]. The three groups met once a month for promotion of activities concerning dengue. The assessment and reassessment showed changes in the children's and their family behavior such as an increase in basic knowledge^[19], and better garbage disposal by the family aiding solution of the dengue problem in the community^[15]. The basic knowledge increased post-activities, but the two questions "*Aedes aegypti* is a conductor of dengue fever" and "managing garbage in your house can prevent dengue fever" did not show significantly different statistics. It may be that the scientific name of the mosquito "*Aedes aegypti*" is not common knowledge, while the item of management garbage to prevent dengue fever may be complex for children who cannot relate garbage, to mosquitos, and dengue fever. The growth and development stage of the children and their knowledge were not a focus of the study. Accordingly the questions 4, 5, 7, and 8 were more correct post-activities ($P < 0.05$) and questions 3, 6, 13, and 17 were significantly better post-activities ($P < 0.001$), these items involved signs and symptoms of dengue and solutions which are presented in the common media such as television. Thus, dengue knowledge can be taught to children in community based schools^[7,8,19,20].

The larval index (BI, HI, and CI) of after the activities were decreased to 7%, 5%, and 1 %, its level was low compared to the standard level of the Thai Ministry of Public Health. However, it showed the results of small sample size which

were estimated lower than 100 households^[11]. In the study, the larval indices were indirect as the outcome of children's knowledge and activities, but they were confirmed as primary measurement tools for monitoring larval populations and are easily used in the community. Moreover, the morbidity and mortality rate of dengue was not present during the study and one year after the project was closed. However, the children in the Islamic religious school need formal education regarding dengue because it was successful in developing knowledge^[8,20].

The highlight of the children's activities was "the recycle garbage bank" because they can run the process of activities by themselves. The support group gave partial support sometimes during the study. The activity was a strategy developed by the community. Parents supported the children to collect and select recyclable garbage for sending to the garbage bank at school. Moreover, their families participated in the larval indices survey. The study showed the participation of all stakeholders was important for dengue control in the community and confirms previous studies of dengue in schools^[18,19]. Particularly, the dengue knowledge and activities of children in the religious school which opens only Saturday and Sunday are needed to improve because the school is at the center of the community.

The number of children in the Islamic religious school was dynamic because the numbers changed during the study program as the students need to volunteer, and thus their available time is based upon the number of classes they have. The sample size in the study was not the same children in the pre and post-activities. In a future study, the study needs to test knowledge the number of participants in a strict manner. Although, the larval indices were underestimated the papal indices which are related to adult mosquito can be implemented in practical measurements in the community.

Conflict of interest statement

We declare that we have no conflict of interest.

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