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Effect of community participation on household environment to mitigate dengue transmission in Thailand

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Abstract. Due to the absence of dengue vaccination, vector control is the only measure to prevent dengue outbreaks. The key element of dengue prevention is to eliminate vector habitats. Clean household environment, preventive behaviors of household members and community participation in dengue prevention and control are key successful elements. This study aimed to investigate the associations between environmental factors, dengue knowledge, perception and preventive behaviors of household and collaboration of community members and household risk of dengue by using mixed methods. One dengue epidemic province was selected from each region of Thailand including Bangkok. Two districts, one from the highest and another from the lowest dengue incidence areas, were selected from those provinces. The household leaders, community members, and local authorities in highest dengue incidence areas were interviewed by using questionnaire and through group interviews. The environment of each selected household was observed. Of 4,561 households, 194 were reported having dengue case(s) in the past year and that outdoor solid waste disposal significantly influenced household risk of dengue (OR=1.62; 95% CI=1.16-2.29). In contrast, having gardening areas reduced dengue risk at household level by 32%. High level of community participation in dengue prevention and control in uninfected areas and the information from local authorities and community members reconfirmed that community participation was the key factor against dengue outbreaks. Sustainable process of encouraging community members to eliminate vector breeding sites such as outdoor solid waste disposal is likely to lead to an achievement in dengue prevention and control.

INTRODUCTION

Dengue virus (DENV) infection, an arthropod borne disease, has been a global health problem for many decades. After being infected by DENV, an infected person may or may not present manifestations, as dengue fever (DF) or dengue hemorrhagic fever (DHF). The latter is a main cause of hospitalization and death among children in Southeast Asia (SEA). Despite dengue prevention and control efforts, DF/DHF remains a critical public health problem in this region (SEARO, 2011). Since no specific treatment and vaccination programs exist, vector control is only key measure to mitigate DENV infection (SEARO, 2011; Simmons *et al.*, 2012).

In Thailand, the first dengue case was reported in the 1950s, and since then DENV has become a major public health problem. About 60,000 DENV cases were reported by the Ministry of Public Health annually (Bureau of Epidemiology, 2012). For many decades, vector control programs have been implemented countrywide to prevent and control DENV infection but failed to achieve their targets. Such programs have focused on spraying insecticides to kill adult mosquitoes and using Abate sand granules as larvicides. Previous research reported positive relationships between poor collaboration in management of community environment and density of dengue vector breeding sites (Gould *et al.*, 1971; Kittayapong *et al.*, 2006; Morrison *et al.*, 2006; Cordeiro *et al.*, 2007; Arunachalam *et al.*, 2010). Studies in Thailand and Mexico reported the significant effects of household environment on dengue transmission (Siqueira *et al.*, 2004; Vanwambeke *et al.*, 2006; Thammapalo *et al.*, 2008). Previous studies in the Caribbean and Latin America demonstrated the effect of community participation in diminishing favorable household environments of dengue vectors that led to success in dengue prevention and control (Rosenbaum *et al.*, 1995; Tapia-Conyer *et al.*, 2012). Besides environmental factors, awareness and knowledge of dengue prevention among Thai citizens were responsible for a significant reduction in dengue transmission (Van Benthem *et al.*, 2002; Phuanukoonnom *et al.*, 2005). Awareness and knowledge of dengue prevention among community members showed a negative association with dengue transmission (Van Benthem *et al.*, 2002; Kittayapong *et al.*, 2006; Phuanukoonnon *et al.*, 2005; Capara *et al.*, 2009; Cho *et al.*, 2011).

However, knowledge about the dynamics of household awareness, household ecology, community participation and dengue transmission is rather limited. Such knowledge is extremely crucial for developing effective strategies for dengue prevention and control. Therefore, the present study wasconducted to investigate such dynamics in Thailand.

MATERIALS AND METHODS

Study areas and samples

The present study obtained data from a cross-sectional study in 2011 that aimed to evaluate the National Program of DHF surveillance, prevention and control in Thailand, launched since 1960s. The cross-sectional study was conducted in four distinct Thai geographical regions: the north (Tak Province), the northeast (Surin Province), central Thailand (Chantaburi Province), the south (Phangnga Province) and Bangkok (Figure 1). In each region, the highest dengue incidence province was selected. All districts of each selected province and Bangkok were categorized into high and low epidemic areas, and then one district was selected from each category. Thereafter, all villages were selected from three subdistricts, one from urban area, and two from semirural and rural areas. Finally, 4,761 household heads of 112 villages were systematically selected and interviewed. Their houses were also surveyed regarding household construction and ecology.

This study also included stakeholders of dengue prevention and control in each sub-district that comprised representatives of health personnel, teachers, local authority, community members, community leaders and health volunteers. These representatives participated in group interviews.

Data collection and instruments

The study employed a mixed method design. For the quantitative method, the household head was informed of the study and provided an information sheet before signing the informed consent form. For each household, an observational checklist was used to observe shrubbery areas, disposal of garbage, water storage, and wired-screening windows/doors. The household heads were interviewed on their

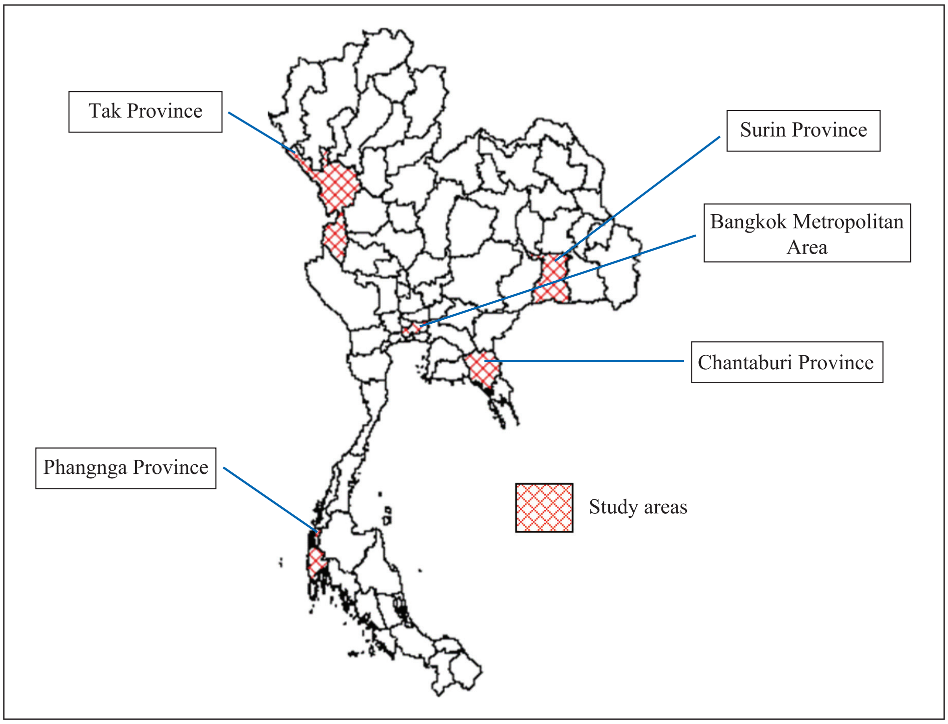

Figure 1. Study areas

knowledge related to dengue cause, mode of transmission, signs and symptoms and severity, perception and preventive behaviors (KPB) using a structured questionnaire. To measure knowledge of household heads, an 11-item questionnaire was used, and perception included dengue infection risk and severity of household heads measured usinga seven-item questionnaire with a three-part rating scale (1=disagree, 2=uncertain, 3= agree). We measured preventive behaviors related to dengue by a six-item questionnaire and community participation was measured by as five-item questionnaire. The validity of questionnaires was tested by coefficient of Chronbach's alpha. The reliability for knowledge, perception and preventive behavior were 0.75, 0.72 and 0.81, respectively.

For the qualitative method, specific group interviews were conducted among 112 representatives from various agencies to understand existing collaboration in dengue prevention and control among community networks using a semi-structured questionnaire. The information during group interview was noted by two note takers who were well trained by the authors.

Each household was categorized into an infected or an uninfected household regarding history of having or not having household members becoming sick with DF/DHF over the past year. All dengue reported households were validated with dengue investigation reportsby local public health staff to include only indigenous cases. Households with imported cases were categorized as uninfected households.

Data analysis

For quantitative analysis, all answers of the KPB questionnaire were assigned a score and then the total score was added for each participant. For ecological factors, each item was assigned a binary outcome and then the frequency was quantified. All scores and checklist items were then compared between infected and uninfected household using chi-square test or t-test, and finally, multiple logistic regression was employed to estimate odds ratio (OR). The significant level was applied at 0.05.

For the qualitative analysis, all messages from interviewees were transcribed and the transcribed texts were re-read to construct codes and identify principle themes. Data were also triangulated across data collection methods and semistructured interviews. We omitted all participant names to preserve their identification.

This study was given the permission to use the data from the national program by the authority of the Bureau of Vector Borne Disease, Ministry of Public Health. Also the present study was approved by the ethics review board of Mahidol University to be exempt from ethics review due to making use of secondary data.

RESULTS

The findings of this study were drawn from quantitative and qualitative information to identify important factors of dengue prevention and control at household and community levels.

The survey used both interview questionnaires and environmental observational checklists conducted among 4,761 households in 5 provinces. The majority of participants were female (71.2%), almost half of them (41.77%) were farmers, 75.5% were married, and 70% had education lower than high school. Of 4,761 participants, 44.8% lived in rural areas, and one third lived in semi-urban areas. The report of dengue cases in the previous year was found among 194 households (4.07%) (Table 1).

We did not find any difference of KPB scores between infected and uninfected households, but a high level of community collaboration was found in uninfected households (Table 2).

Table 1. Characteristics of 4,761 household heads

Variable	Number	Percent
Sex		
Male	1,356	28.5
Female	3,405	71.5
Occupation		
Farmer	1,989	41.8
Daily employed	922	19.4
Merchant	786	16.5
Housewife	737	15.5
Monthly employed	138	2.9
Unemployed	264	5.6
Student	98	2.1
Others	266	5.6
Marital status		
Single	612	12.9
Married	3,596	75.5
Divorced/Widowed	553	11.6
Education		
Illiterate	386	8.1
Primary school	2,966	62.3
High school	972	20.4
Vocational school	129	2.7
Bachelor or higher	308	6.5
Types of residential area		
Rural	2,133	44.8
Urban	1,214	25.5
Semi-urban	1,414	29.7
Report dengue cases in previous year		
Yes	194	4.1
No	4,556	95.9

Table 2. Comparison of KPB between infected and uninfected households

Score	Infected household (n =194)		Uninfected household (n=4,556)		*P*-value*
	Mean	SD	Mean	SD	
Knowledge of dengue	8.0	1.6	7.9	1.6	0.49
Perception of dengue susceptibility	14.5	1.0	14.4	1.2	0.61
Perception of dengue virulence	5.7	0.6	5.7	0.6	0.50
Behavior of dengue prevention	20.2	1.4	20.2	1.6	0.93
Community participation in dengue prevention and control	8.0	1.9	8.3	1.9	0.04

* t-test, *P*-value <0.05 is significant

The ecological observation found residential characteristics between infected households and uninfected households were significantly different in two items: firstly, infected households had a lower proportion of houses with gardening areas than uninfected households (3.47 and 5.03% respectively, *P*=0.007). Finally, infected households had a high proportion of poor management of solid waste disposal in residential areas (5.96 and 3.75% respectively, *P*=0.004) (Table 3).

Table 3. Comparison of residential characteristics between infected and uninfected households

Residential characteristics	Infected household		Uninfected household		*P*-value*
	n=194	%	n=4,556	%	
Types of residential construction					0.84
Commercial building	6	3.1	190	96.9	
Single house	175	4.2	4,030	95.8	
Townhouse	5	4.0	120	96.0	
Condominium/Apartment	8	3.6	216	96.4	
Residential function					0.83
Shophouse	161	4.1	3,818	95.9	
Home-basedindustrial	32	4.4	698	95.6	
Residential	2	3.9	50	96.2	
Window/doorwired screen					0.39
No	148	4.3	3,329	95.7	
Yes	46	3.7	1,197	96.3	
With gardeningarea					0.007
No	97	5.1	1,830	94.9	
Yes	97	3.5	2,697	96.5	
Surrounded by bushes					0.933
No	43	4.1	1,012	95.9	
Yes	152	4.1	3,525	95.9	
Availablepiped water					0.533
No	59	4.4	1,288	95.6	
Yes	135	4.0	3,255	96.0	
Container with lid					0.604
No	32	4.3	708	95.7	
Yes	163	4.1	3,852	95.9	
Indoor containerwithout lid					0.095
No	62	4.9	1,203	95.1	
Yes	133	3.8	3,355	96.2	
Outdoor container without lid					0.423
No	116	3.9	2,839	96.1	
Yes	79	4.4	1,716	95.6	
Indoor solid waste disposal					0.436
No	175	4.0	4,161	96.0	
Yes	20	4.8	394	95.2	
Outdoor solid waste disposal					0.004
No	149	3.9	3,825	96.1	
Yes	46	6.0	726	94.0	

* Chi-square test, *P*-value<0.05 is significant

Binary logistic regression revealed significant effects of shrubbery areas (OR=0.68; 95%CI 0.51–0.90) and having outdoor solid waste disposal (OR=1.63; 95%CI 1.16–2.29) on reducing dengue risk at the household level. However, KPB and other residential characteristics did not present any significant effect on dengue risk. After adjusting for epidemic area and levels of KPB, the significant effects of both shrubbery areas and having solid waste disposal surrounding house on dengue risk remained (Table 4).

Specific group interviews among local authorities, teachers, health personnel, community members and health volunteers were conducted during the survey. The information from group interviews revealed that key elements of dengue prevention and control success were community participation in getting rid of habitat of dengue vectors and a stakeholder agreement, as described below.

Community participation in getting rid of dengue vector's habitats

Regarding group interview, we found a significant amount of community participation in getting rid of dengue vector's habitats on dengue prevention and control in dengue free areas. The community members worked together with stakeholders to eliminate dengue vector breeding sites and clean water storages weekly. Regular campaigns for vector control in dengue season was not an effective strategy to reduce dengue infection. Empowerment and encouragement of community members to strictly keep their own areas clean of vector habitats were crucial strategies of dengue prevention.

As participants mentioned during group interviews "All stakeholders are strictly working together to get rid of disposals, solid garbage, and clean water supplies weekly, and each group has a responsible

Table 4. Related factors to household risk of dengue

Variable	OR	95% CI	AdjOR[a]	95% CI
Epidemic area	1.03	0.86 to 1.25		
Knowledge of dengue	1.03	0.91 to 1.17		
Perception of dengue susceptibility	0.92	0.74 to 1.14		
Perception of dengue virulence	1.00	0.92 to 1.10		
Behavior of dengue prevention	1.03	0.94 to 1.13		
Community collaboration in dengue prevention and control	0.93	0.87 to 1.00		
Residential construction	1.01	0.94 to 1.10		
Purpose of using dwelling	1.12	0.8 to 1.55		
Window/door wired screen	0.86	0.62 to 1.21		
Having gardening area	0.68*	0.51 to 0.90	0.68*	0.51 to 0.90
Surrounded by bushes	1.01	0.72 to 1.43		
Available of pipe water	0.91	0.66 to 1.24		
Indoor container with lid	0.94	0.64 to 1.38		
Indoor container without lid	0.77	0.56 to 1.05		
Outdoor container without lid	1.13	0.84 to 1.51		
Indoor solid waste disposal	1.21	0.75 to 1.94		
Outdoor solid waste disposal	1.63*	1.16 to 2.29	1.62*	1.13 to 2.32

[a]Adjusted for preventive behavior and epidemic area, * *P*-value < 0.05

area. For example, the school area was the responsibility of teachers and students, the monastery area was the responsibility of monks, public areas were the responsibility of health volunteers, and of course, each community member was responsible to his or her own house" (Local authority of subdistrict in southern Thailandthat had been free from dengue for ten years).

"…children were key persons in community empowerment; we regularly educated students on the importance of garbage management for not only dengue prevention but also hygienic perspective. In addition, we regularly visited students' houses to promote the best practices among student" (School teachers came from subdistricts of southern Thailand that had been free from dengue for ten years).

On the other hand, in areas with continual dengue epidemics, community members thought vector control was not their responsibility. This perception was a crucial factor for dengue prevention and control. As participants mentioned during group interviews "...we asked for their collaboration but failed, ...in fact they permitted us to manage solid garbage from their household surroundings, ...but we don't have enough timeand manpower to do it weekly ...some households did not allow us to get inside their houses to clean water storages..." (Health volunteer in northern Thailand).

A stakeholder agreement

Another issue obtained from the group interview was the agreement of stakeholders in dengue prevention. This issue was a critical factor in the decentralized area. Integrated plans and clarified responsibilities of stakeholders such as local authority providing funding and facilities for dengue prevention and control, public health staff to conduct activities to achieve the goals of dengue prevention and community members to organize themselves to manage disposal garbage effectively.

Public health staff said that "...we, the local authority, the school teachers, the students and the public health staff, sit together and set appropriate action plans for dengue prevention and control. We do believe that fighting dengue is not a responsibility of a particular organization but is the responsibility of the whole community and all organization. We appointed key persons from each party whose cell-phone must be always turned on; working together and sharing resources are key success factors of our area" (Public health staff in eastern Thailand).

This study found a close relationship between household risk of dengue and the amount of garbage in household surroundings. The better the community participation in garbage management the more likely was the possibility to achieve better results of a dengue prevention and control.

DISCUSSION

After adjusting for dengue knowledge, perception and preventive behavior, this present study found the significant effects of two spatial factors, outdoor solid waste disposal and having gardening areas among houses. The findings confirmed the significance of the eco-health perspective on dynamics of dengue transmission. Poor management of outdoor solid waste disposal influenced household risk of dengue infection, while havings hrubbery areas reduced household risk of dengue infection. In addition, our result reconfirmed that strong participation among community members and related stakeholders, such as local authority, public health staff, school teachers etc., were the key factors of dengue prevention and control success (Rosenbaum *et al.*, 1995; Van Benthem *et al.*, 2002; Phuanukoonnon *et al.*, 2005; Kittayapong *et al.*, 2006; Tapia-Conyer *et al.*, 2012).

The positive effect of outdoor solid waste disposal in this study was similar to previous studies in Brazil (Braga *et al.*, 2010; Cordeiro *et al.*, 2011). The possible explanation of outdoor solid waste disposal being an influencing factor of dengue risk was that solid wastes are favorable habitats for dengue vector. In other words, increased outdoor solid waste disposal would indirectly increase population density of dengue vectors in household surroundings. Solid wastes such as plastic bottle, plastic bowls etc., filled with rain water were appealing areas for *Aedes* mosquitoes breeding. Moreover, it has been well reported that dengue vectors prefer breeding in natural water than tap water (Morrison *et al.*, 2006; Fock & Alexander, 2006; Arunachalam *et al.*, 2010).

Our study found the preventive effect of having gardening areas on dengue risk and was consistent with other studies in Thailand (Arunachalam *et al.*, 2010; Koyadun *et al.*, 2012). The protective effect of having shrubbery areas in this study is likely explained by the socio-environmental context. Gardening areas are common features in rural areas where community members have strong cohesion and collaboration. Community collaboration is widely recognized as an important factor to successful development in health (Oakley, 1989). Communities with strong collaboration likely lead to appropriate management of solid waste in residential and public areas, to eliminate dengue vectors and reduce the number of dengue cases eventually (Rosenbaum *et al.*, 1995; Tapia-Conyer *et al.*, 2012). Our study emphasized the significant effects of the land cover use on dengue transmission that has been reported in a previous study in Northern Thailand (Vanwambeke *et al.*, 2006). A previous study in Puerto Rico and Thailand revealed the dispersal pattern of dengue vectors in that the majority of female *Aedes* adults did not move but the majority of those did move within 50 meters from their emerging households after 24 hours. Therefore, having gardening areas likely extended the distance of household and its adjacent surroundings to beyond the flight range before prevention and control action could be ordered by local public health staff within 24 hours (Harrington *et al.*, 2005).

In contrast, previous studies in Argentina and Latin America presented dissimilar results (Phuanukoonnon *et al.*, 2005; Vezzani & Albicocco, 2009). The different result may be related to different outcomes of interest. Those previous studies focused on container locations that did or did not have dengue vectors, but not dengue cases.

We found the score of community participation in eliminating vector breeding sites and cleaning water storages was significantly higher in uninfected than infected households. Even though we did not find any significant association between level of community participation and dengue infected household in both binary and multiple logistic regression, the information from the group interview revealed the fact that community participation was the most important factor of dengue prevention and control in free dengue areas. This information reconfirmed previous reports in Latin America and Thailand (Rosenbaum *et al.*, 1995; Van Benthem *et al.*, 2002; Phuanukoonnon *et al.*, 2005; Kittayapong *et al.*, 2006; Tapia-Conyer *et al.*, 2012).

This study did not find any difference in KPB scores between infected and uninfected areas, and could be explained by the continuous operation of community-based health education programs. The non-significant effect of KPB in this study confirmed that community-based health education related to dengue may not be sufficient for dengue prevention and control. Building awareness of dengue consequence among community members and eliminating solid waste disposal in residential areas to destroy breeding sites may likely to be an effective dengue prevention measure.

In addition, this study did not find any significant effect of water supply on dengue risk that was different from previous studies. This may related to the country-wide implementation of the water storage treatment with Abate sand (Gould *et al.*, 1971; Vezzani & Albicocco, 2009). The major limitation in this study was lack of vector information, but with the mixed method applied, quantitative and qualitative data collection was the major strength point. By interview, we obtained the facts from community members and all stakeholders regarding the measures used against dengue in each community. Based on our knowledge, this study is just one of the few studies that applied mixed method at household levels and investigated KPB and environmental factors simultaneously.

Nevertheless, our findings provide significant information for public health authorities to set up a better strategic plan of dengue prevention and control strategies. Our study highlighted that community awareness of dengue consequence can establish strong participation among community members, and therefore, a sustainable process to encourage community members to maintain efforts in keeping their households as dengue free areas.

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