

An analysis of the Implementation of the Source Reduction Program in Response to 2010 Dengue Epidemic

Tuan Yen-Chang¹、Wang Yu-Zhu³、Huang Chi-Chuan³、Wang Chin-Hsien²
Chang Chao-Ching³、Lin Li-Jen³、Lee Tsuey-Feng¹、Shih Wen-Yi⁴

1. Third Branch, Centers for Disease Control, Taiwan
2. Fourth Branch, Centers for Disease Control, Taiwan
3. Fifth Branch, Centers for Disease Control, Taiwan
4. Deputy Director-General, Centers for Disease Control, Taiwan

Abstract

For the first time, a source reduction program was devised by the central government that delegated the responsibility of implementation to local governments in areas of Tainan County/City and Kaohsiung County/City. This program was launched through multi-media dissemination of 13 mnemonic phrases created for source reduction, followed by three major activities, namely motivating citizens to conduct indoor source reduction, requiring environmental cleaning workers to enforce outdoor source reduction, and encouraging schools to participate in community source reduction. As a result, 31 villages in Kaohsiung City and 20 villages in Tainan City took part in the indoor source reduction activity and have removed a cumulative total number of 62,973 pieces (amounting to 39.7% of the target volume) and 175,156 pieces (196.2% of the target volume) of containers, respectively. Also, in the outdoor source reduction strategy was implemented in 11 administrative

districts in Kaohsiung City, 6 administrative districts in Tainan City, and Fengshan City of Kaohsiung County with notable results. A further analysis of the containers collected in Kaohsiung City and Fengshan City during outdoor source reduction shows that category I containers account for the highest share of 85.6%, followed by category VI containers amounting to 7.9% of the total volume collected. In particular, a total of 25,483 students from 106 schools in the four counties/cities dedicated themselves to community-based source reduction activity and have removed a total of 221,254 pieces of containers. A further analysis of containers removed by students in Kaohsiung County/City and Tainan County indicates

INSIDE

- 164 An analysis of the Implementation of the Source Reduction Program in Response to 2010 Dengue Epidemic
- 176 The 2010 Executive Report for Dengue Fever Prevention and Control in Southern Taiwan and Health Education Strategies

The Taiwan Epidemiology Bulletin series of publications is published by Centers for Disease Control, Department of Health, Taiwan (R.O.C.) since Dec 15, 1984.

Publisher : Feng-Yee Chang

Editor-in-Chief : Yi-Chun Wu

Executive Editor : Li-Gin Wu, Hsiu-Lan Liu

Telephone No : (02) 2395-9825

Address : No.6, Linshen S. Road, Taipei, Taiwan 100 (R.O.C.)

Website : <http://teb.cdc.gov.tw/>

Suggested Citation :

[Author].[Article title].Taiwan Epidemiol Bull 2011;27:[inclusive page numbers].

that category I container account for the highest share of 85.8%, followed by category VI containers amounting to 6.2% of the total volume collected. In consideration of the tremendous overall accomplishments, the source reduction program and its implementation method can be a model in developing plans for future dengue fever control.

Keywords : dengue fever, source reduction

Introduction

Dengue fever is mainly transmitted through bite of *Aedes aegypti* and *Aedes albopictus*. Since both *Aedes* mosquitoes go through four stages – namely egg, larvae, pupa, and adult – in their life cycle, and the larvae and pupa stages will have to take place in a water-holding container, source reduction has become the major policy in dengue vector control [1]. However, because of limited manpower in the public sector and changed lifestyle in general population, the containers discarded increased more quickly in number

than those removed, making the container source always there. When it rained, or when typhoons struck and brought heavy rains, these containers were very likely to become mosquito breeding sites and might cause the dengue vector density to increase rapidly. In this situation, the risk of dengue outbreaks would become very high once the dengue virus was introduced into the mosquito population. Therefore, the most efficient strategy in decreasing vector density would be source reduction, which refers to the elimination of possible breeding sites through risk management methods.

A study conducted in the Piedmont Community in North Carolina, USA, during 2002-2003 showed that source reduction activities implemented in experiment areas on a monthly basis were able to alter the spatial distribution of pupae of *Aedes albopictus* [2]. Singapore's experience in dengue control indicated that source reduction activities conducted through community mobilization should be implemented continuously [3]. During the dengue epidemic period in 2006 in Kaohsiung City, Taiwan, the Civil Affairs Bureau together with the Environmental Protection Bureau of the City Government initiated a source reduction campaign in 77 villages in Cianzhen, Lingya, and Sanmin Districts. Several weeks after the campaign, no more dengue cases were identified in these villages except scattered cases in five of them [4].

Another successful example of source reduction occurred in the Wujia area of Fengshan City in Kaohsiung County, Taiwan, in 2009, where several bureaus in the County Government were asked to organize a source

reduction campaign and make it become a part of the outdoor education to mobilize students in the elementary schools of the area to participate the campaign. In 2010, when the Central Dengue Fever Epidemic Command Center was activated in response to the upcoming epidemic season for dengue infection, a source reduction program was formulated based on the experience of Kaohsiung City in 2006 and of Kaohsiung County in 2009. This program was for the first time fully applied to Tainan City and County as well as Kaohsiung City and County on 27 October, 2010, under the supervision and instruction of the Command Center. This program integrated all resources in the Bureaus of Civil Affairs, Education, Environmental Protection, and Health in local governments and required that these bureaus worked together to mobilize community members and students in elementary and junior high schools to join the source reduction activities. All collected and removed containers in the activities were classified and calculated for further analysis by the relevant bureaus. Through this work pattern, we hope that community members would learn how to appropriately manage the containers and students would be able to motivate their parents to commit to community disease control, thus indirectly decreasing the dengue vector density in the community.

Materials and Methods

1. To raise people's awareness about breeding containers through public media

In order to provide a standard checklist

to community members and workers in environmental protection and health authorities so that they can easily identify possible breeding containers and make classification, the Dengue Vector Density Investigation Record Form routinely used by disease control workers was selected as a reference in developing the new form. In the reference form, the possible breeding containers were divided into 12 categories, including (1) vase, (2) saucer, (3) drainage ditch, (4) water tower or cooling tower, (5) canvas or plastic canvas for shelter use, (6) bucket, pottery pot or basin, (7) polystyrene box and plate, or plastic basket, (8) toilet bowl or toilet tank, (9) cup, bottle, bowl, can, or box, (10) flooded basement or deserted air raid shelter, (11) discarded tire, and (12) others. In the new form, the classification of possible breeding containers was designed with mnemonic phrases in Chinese for people to easily remember and identify the various types of containers. The new form was consisted of 13 categories. They are: (1) bottle and can, or discarded car battery, (2) discarded tire, (3) bathtub or water pot, (4) washing machine tub, (5) polystyrene box, (6) candy box, biscuit box, or lunch box, (7) toilet bowl, (8) canvas or plastic canvas, (9) aquarium tank, (10) helmet, (11) deserted betel nut stand or deserted roadside stand, (12) cooling tower, and (13) bucket, basin, plate, or ladle.

The 13-category classification was used as the heart of policy dissemination to raise citizens' awareness of source reduction and their involvement in policy implementation through the use of multimedia tools, including three-dimensional and two-dimensional media. In three-dimensional media, a large

red cloth strip describing the mnemonic phrase of the 13-category classification was made and hung on the outer wall of buildings of the government agencies or schools, or mounted on the side of garbage trucks. A tape recorded in mandarin and Taiwanese languages was broadcasted by specialized vans going around the streets or by garbage trucks on-duty to remind citizens to clean water-holding containers at all time to protect the health of everybody, and to prompt individuals to inspect, turn upside down, clean, and brush the water-holding containers in their environment. These messages were also painted on the exterior of taxies of the Taiwan Taxi Fleet. For the first time, government policy was disseminated through this kind of vehicle. Moreover, a public service announcement (PSA) was produced and routinely disseminated during commercial breaks of TV news program of major broadcasters. In addition, county/city governments were required to coordinate local TV stations or broadcast companies to air this PSA on source reduction. As for two-dimensional media, dissemination materials for source reduction were created, and they were intensively advertised in the national and local sections of four major newspapers and displayed in LED monitors set up in railway stations, highway rest areas, national hospitals, motor vehicles offices, and local tax bureaus. Schools at different level of education were required to routinely show the dissemination materials in their electronic boards or LED monitors, or to use health education posters provided by Taiwan Centers for Disease Control (Taiwan CDC) to raise the awareness on dengue fever among teachers

and students. In addition, web-based media were used for disseminating information about the source reduction policy, where relevant press transcripts were posted on the official Taiwan CDC website and blog.

2. To motivate citizens to conduct indoor source reduction

To administer the campaign, the village chiefs and village officers were required by the Bureau of Civil Affairs of city/county government to first send a notice to each household under their jurisdiction to inform citizens about the container transportation plan of indoor source reduction activity. Then, on the date scheduled for transportation, either the village officer or health worker would educate citizens and call for them to remove all deserted containers found inside the house. Finally, the garbage trucks operated by the Bureau of Environmental Protection of local government would transport the containers away. The campaign had set its goal to collect at least five deserted containers from each household. In order to let citizens participate in the campaign more smoothly, they were not required to classify the removed containers. Large size containers, such as deserted cooling towers, discarded tires, canvases, or polystyrene boxes, found on the date of transportation would have to be removed immediately; otherwise, the owner would be given a notice asking them to resolve the problem it in due time. This campaign activity covered the villages of Wancheng, Wanai, Wanzih, Wanfu, Wanjhong, Wanhua, Wansheng, Wanli, Fongyu, Fongbei, Fongnan, Xingde, Jiantung, and Gangxi in Sanmin District, the villages of Jianxing, Jianhua, Xinjiang, Qiushan, Mingzhuang,

Zhangyi, Aiping, and Liming in Singsing District, the villages of Zhengwen, Zhengyan, Zhengxin, Zhengda, Zhengdao, Zhengren, and Zzhengyi in Linya District, the villages of Changcheng and Sanchuan in Qianjin District of Kaohsiung City; the villages of Kaishan, Wanchang, Yintong, Junwang, Yonghua, Qingnian, and Sanmin in West-central District, the villages of Wennan, Wenhua, Guangzhou, Guozhai, and Jinhua in Southern District, and the villages of Yanping, Guoxing, Xingbei, Xingnan, Zhangde, Yuhuang, Wufu, Sande in Northern District of Tainan City.

3. To enforce outdoor source reduction

The Environmental Protection Bureau of county/city government and the Environmental Cleanliness Unit of township/district office were required to collect, recycle, remove, and transport away the deserted containers found in the daily cleaning activities. These containers were calculated and classified into 13 categories based on the mnemonic 13-category classification method. This activity had set as its goal to collect one deserted container from each household. This meant that the total number of houses in a village was considered the target number for deserted containers to be removed from that village. To calculate the target number of removal for each of the 13 categories, the total number of containers expected to be removed was multiplied by the percentage of each category removed during a similar campaign that took place in Kaohsiung City in 2006. The administrative areas for this activity included all districts in Kaohsiung and

Tainan City and Fengshan City of Kaohsiung County.

4. To encourage schools to participate in community source reduction

This activity was organized by the Education Bureaus of local government to encourage students in elementary and junior high schools to join source reduction in the community, and in doing so hoping that dengue fever prevention could be incorporated into daily lives and early education of young children. In practice, this activity was designed as a part of the outdoor education curriculum. Around 50-100 students from each school were signed up for this activity after obtaining consent from their parents through either the home-school communication book or a special note. These students were first educated about the containers in which *Aedes* mosquitoes were likely to breed in and were subsequently required to collect and remove possible breeding containers outdoor in the community. When students found containers that were too large to be removed or cleaned, they took a note about the container and then forward it to the Bureau of Environmental Protection for transportation. This program was implemented in 18, 4, and 12 schools in Sanmin, Singsing, and Linya Districts of Kaohsiung City, respectively, and in 9, 10, and 12 schools in West-central, Southern, and Northern Districts of Tainan City, respectively, as well as in 30 and 15 schools in Fengshan City of Kaohsiung County and Yongkang City of Tainan City, respectively. A total of 110 schools participated in this activity.

5. To hold a ceremony in honor of participants and for sharing what one has learned

At the end of the activity, the county/city governments would conduct evaluation and rank performance based on the total number of various containers collected by each school and, then, give awards to schools or individuals with good performance. The items of award included a cash prize and trophy for schools, a merit certificate for school personnel in charge of the activity, and a diploma to honor the participants as the “king of source reduction” for students. For each county/city, if the percentage of schools having participated source reduction reached 90 percent or more of the target number of schools, the participants would receive awards according to the criteria listed in the

following table 1. However, for counties/cities where the participation rate was less than 90 percent, participating schools were given No. 4 and No. 10 awards depending on the overall performance of each school, as this helped avoid awarding schools with substandard performance. In addition, schools that collected fewer than 1,000 pieces of containers were not eligible to receive the participation reward. The items (cash prize/trophy/diploma) and amounts (expressed in ten thousand new Taiwanese dollars for cash prize, number of pieces for trophy, and number of students for diploma) of awards for each placing are shown in the table 1.

6. The progress of the source reduction implementation

The progress is described in the table 2.

Table 1. Award table

County/city	target number of schools	No. 1 cash prize ^b /trophy /diploma	No. 2 cash prize ^b /trophy /diploma	No. 3 cash prize ^b /trophy /diploma	No. 4-10 ^a cash prize ^b /diploma	participation reward cash prize ^b
Kaohsiung City	34	3/1/20	2/1/10	1.5/1/5	1/5	0.5
Tainan City	31	3/1/20	2/1/10	1.5/1/5	1/5	0.5
Kaohsiung County	19	3/1/20	2/1/10	1.5/1/5	1/5	0.5
Tainan County	9	3/1/20	2/1/10	1.5/1/5	1/5	0.5

Note^a: The award for schools ranked at No. 7 to No.10 in Kaohsiung and Tainan County was given as the criteria for participation reward. However, if the number of participation school was similar to that in Kaohsiung City, the award could be bestowed as the criteria in Kaohsiung City.

Note^b: Ten thousand to a unit

Table 2. Gantt chart table

Items	Date									
	10/22	10/25	10/26	11/2	11/16	11/22	11/25	12/3	12/31	
Planning	=====									
Plan review			=====							
Personnel training & dissemination through public media				=====						
Indoor source reduction			=====							
Community source reduction			=====							
Outdoor source reduction			=====							
Holding award ceremony								=====		
Conducting post-payment audit on cost of the campaign								=====		

7. Data collection and analysis

The calculation of containers in all categories collected during indoor source reduction and the calculation of containers in category II to category XII collected during outdoor source reduction were expressed in number of pieces. On the other hand, since container in category I and category XIII was so common in outdoor that it was time-consuming to count them in number, weight was used to expressed the amount of container collected during outdoor source reduction. The data obtained from indoor and outdoor source reduction were integrated by the Environmental Protection Bureau of local governments on a daily basis. The calculation of containers collected by students during community source reduction was also expressed in number of pieces and was integrated by Education Bureaus of local governments on a daily basis. The integrated data in excel format for each day were sent to the command center of the campaign by email before 9am of the following day for further analysis.

Results

Although the indoor source reduction activities in Kaohsiung City were originally scheduled during the 44th-46th weeks of the year, the activities were extended to the 47th week and, in response to the dengue epidemic, were restored during the 49th -50th weeks in Linya District. Therefore, the number of containers collected during 44th-46th weeks accounted for a very large share of the total number of containers collected during the whole activity. This activity was implemented in 31 villages in Kaohsiung, and the goal was to have a total of 158,660 pieces of containers removed. However, only 62,973 pieces (accounted for 39.7% of the target) of containers had been collected, failing to reach its goal [Figure 1]. In Tainan City, the indoor source reduction activity was conducted in 20 villages, and the goal was to have a total of 89,285 pieces of containers collected. In fact, 175,156 pieces (accounted for 196.2% of the target) of containers had been collected, surpassing its goal [Figure 2]. Most of these containers were collected during the

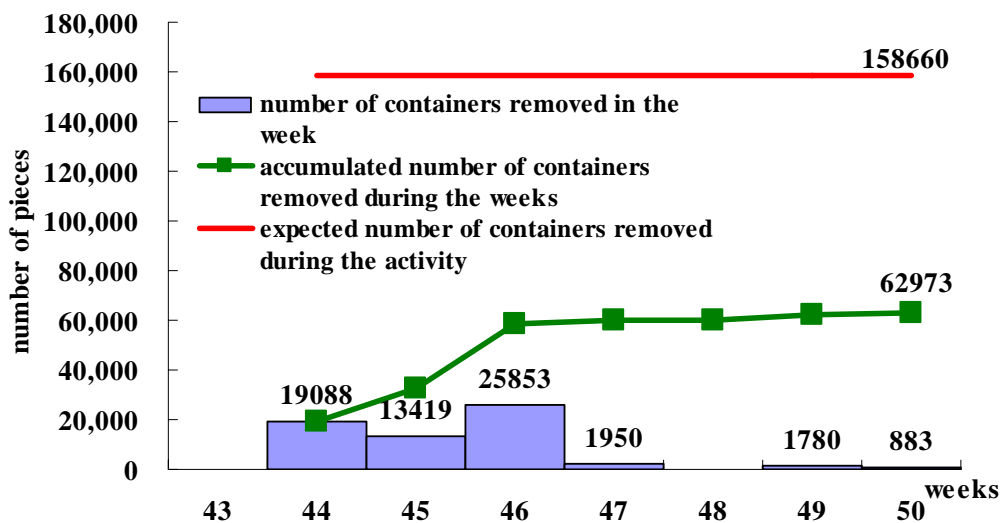


Figure 1. Number of containers collected during indoor source reduction activity in Kaohsiung City by week

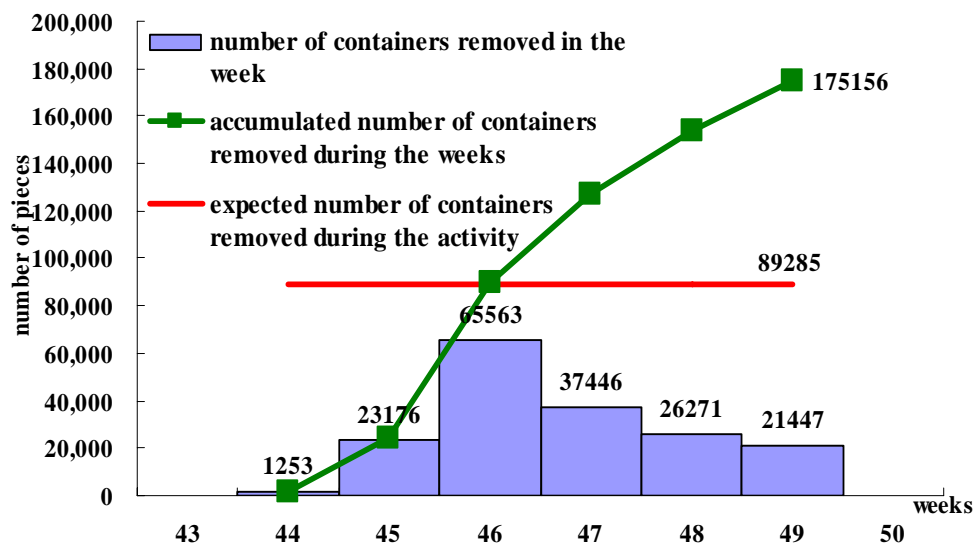


Figure 2. Number of containers collected during indoor source reduction activity in Tainan City by week

Table 3. Number and weight of containers removed during indoor and outdoor source reduction by county/cit

county/city	indoor source reduction			outdoor source reduction					
	A	B	B/A	C	D	D/C	E	F	F/E
Kaohsiung City	158660	62973	39.7	55844	46270	82.9	146564	63954	43.6
Tainan City	89285	175156	196.2	25630	467623	1824.5	67447	169392	251.1
Kaohsiung County	not participating in the activity			12026	18161	151.0	31648	11096	35.1
Tainan County	not participating in the activity			not participating in the activity					

Note: A: estimated number of containers; B: number of removed containers; B/A: implementation rate (%); C: estimated weight of category I & XIII containers; D: weight of removed category I & XIII containers ; D/C: implementation rate (%); E: estimated number of category II to XII containers; F: number of removed category II to XII containers; F/E: implementation rate (%)

45th-49th weeks in Tainan City, and the activity was terminated in the 50th week because of a slowdown in the epidemic. Data from indoor source reduction activity in each county are shown in Table 3.

Outdoor source reduction activity was conducted from November 1 to December 23, 2010. The number and weight of containers removed during this period are presented in Table 3. This table shows that the numbers of pieces for category II to XII containers

removed were higher than the expected numbers only in Tainan City and the weight of pieces for category I and XIII containers were higher than the expected weight in Tainan City and Kaohsiung County. However, the weight of removed containers in Tainan City took into account containers transported by recyclable waste collection trucks on request of citizens, whereas containers collected this way were not included in data from Kaohsiung

County/City. Table 4 provides the number and percentage of pieces for each category of containers collected in Kaohsiung City and County but does not include data from Tainan City. This table shows that category I recorded the highest percentage, 85.61%, followed by category VI, 7.93%. The analysis of percentage for each category of containers in individual administrative districts of Kaohsiung City shows some unusual results occurred in several districts. For example, the percentage for category V reached as high as 9.58% in Singsing district, the percentage for category II and category X were 2.24% and 1.92%, respectively, in Qianjin District, and the percentage for category VI reached as high as 27.85% in Xiaogang District. In addition, the fact that more than ten thousand pieces of containers per week have been transported away by the Environmental Cleanliness Unit in Kaohsiung City, Tainan City, and Fengshan City of Kaohsiung County revealed that there was a need to strengthen public education about the cleaning and

maintenance of environment to citizens in these areas (note: those data are not presented here).

For community source reduction implemented by schools, based on the distribution of awards, schools in Fengshan City of Kaohsiung County had the highest percentage of award winners, reaching 100%, followed by those in Yongkang City of Tainan County, 86.7%, in Tainan City, 65.5%, and lastly in Kaohsiung City, 62.5%. This result shows that all participating schools in Kaohsiung County had collected more than 1,000 pieces of containers in the community source reduction campaign initiated by the Education Bureau, highlighting an active attitude in the activity. A total of 25,483 students and teachers from 106 schools participated in the activity, and a total of 221,254 pieces of containers was removed. The percentage for each category of containers was calculated for those collected by the Kaohsiung City and County and Tainan County. The result

Table 4. Number and percentage for each category of containers removed during outdoor source reduction in Kaohsiung County/Cit

county/city		container category												
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
Kaohsiung City	number of pieces	406880	3681	280	61	11779	43606	596	994	215	2716	14	12	11165
	percentage (%)	84.42	0.76	0.06	0.01	2.44	9.05	0.12	0.21	0.04	0.56	0.00	0.00	2.32
Fengshan City	number of pieces	147000	197	12	8	2654	7703	71	140	5	305	1	0	6922
	percentage (%)	89.08	0.12	0.01	0.00	1.61	4.67	0.04	0.08	0.00	0.18	0.00	0.00	4.19
subtotal number	number of pieces	553880	3878	292	69	14433	51309	667	1134	220	3021	15	12	18087
	percentage (%)	85.61	0.60	0.05	0.01	2.23	7.93	0.10	0.18	0.03	0.47	0.00	0.00	2.80

shows that category I accounts for the highest percentage, 85.81%, followed by category VI, 6.17% (Table 5). The percentage for each category of containers collected in Tainan City is not included in this Table because schools in this city did not perform classification according to the 13 categories of containers and adopted a different approach from other counties/cities by asking students to either collect containers on the way to school or bring deserted containers from their home to school.

Discussions

Source reduction was included as one of the dengue control strategies conducted in ordinary time in the dengue control guidelines. However, there was no detail description about the responsibility of each government office and the implementation method of the strategy. It was the campaign discussed in this paper that established the implementation detail and for the first time fulfilled the

strategy in four counties/cities of southern Taiwan through the operation of the 2010 Dengue Control Command Center that mobilized the Bureaus of Civil Affairs, Bureaus of Education, Bureaus of Environmental Protection, and Bureaus of Health in local governments to administer a multi-office collaborative program. In this program, the target containers to be removed covered the commonsense items of bottles and cans (i.e. categories I and XIII) and those not traditionally perceived as containers, such as deserted tires and canvases (i.e. categories II and VIII). In addition, at the beginning of the program, the 13-category classification information was used as the focal point of policy dissemination to raise citizens' awareness of source reduction through the use of multimedia tools, hoping that citizens and relevant authorities would become deeply involved in policy implementation and thus enable the goal of "managing objects with owner, removing object without owner" to be achieved.

Table 5. Statistics on the implementation of community source reduction by county/city

county/city	A	B	B/A	container category													C	D	C/D
				I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII			
Tainan City	29	19	65.5%	no data available													109940	15336	7.2
Kaohsiung City	32	20	62.5%	24401	49	4	0	322	4614	0	53	3	32	14	1	2910	32403	5691	5.7
Kaohsiung County	30	30	100%	53911	317	2	0	120	129	2	40	4	106	0	0	980	55611	3102	17.9
Tainan County	15	13	86.7%	17206	211	27	0	513	2126	277	544	8	90	13	2	2283	23300	1354	17.2
subtotal number				95518	577	33	0	955	6869	279	637	15	228	27	3	6173	111314*	25483	
Percentage (%)				85.81	0.52	0.03	0	0.86	6.17	0.25	0.57	0.01	0.20	0.02	0	5.55	100*		

Note*: Not including data from Tainan City. A: number of mobilized school; B: number of award-winning school; B/A: percentage of award winner; C: number of removed container; D: number of mobilized person; C/D: average number of removed container per person

In indoor source reduction activity, the number of containers removed in Tainan City exceeded the number estimated on the basis of the goal of collecting five deserted containers from each house, whereas Kaohsiung City reached only 39.7% of the estimate. A further exploration found that the difference might result from different implementation methods between the two cities. In Tainan City, health workers actively visited citizens in their homes, taught them about the identification of deserted containers, and encouraged them to remove those containers. These dissemination actions might have produced a positive impact, at least to some degree, on the results of source reduction. However, because we did not have baseline number of containers in the houses of these two cities and the goal was decided arbitrarily, it was difficult to measure whether the low percentage in Kaohsiung City resulted from insufficient effort or having a cleaner environment. Nevertheless, the actions taken by Tainan City were able to not only inspire citizen behavior in managing containers but also reach the purpose of source recycling.

The areas in which outdoor source reduction was implemented were expanded to Kaohsiung City, Tainan City, and Fengshan City of Kaohsiung County, and “one container for one house” was set as the goal for implementation. The data show that Tainan City had removed containers greatly exceeding its goal in both the number and weight of containers. This was because the containers transported by recyclable waste collection trucks on request of citizens had been included into the statistics from Tainan City, but similar data were not included in

Kaohsiung County/City. The calculation method used by Tainan City provided an alternative for data analysis, but this method might have led to an overestimation of the effectiveness of. In addition, from the standpoint of the number of pieces of removed containers, both Kaohsiung County and City have failed to achieve the goal. As mentioned in the above paragraph, because no baseline data were available for both of them, we could not determine whether the results were caused by insufficient effort. However, given that a large amount of deserted containers had been removed, it was likely that the source reduction campaign had actually risen awareness about the mnemonic phrases of the 13-category classification scheme among environmental protection workers, who subsequently enforced source reduction even in narrow streets and blind corners.

For the first time, the students in schools of the four counties/cities were mobilized to participate in community source reduction for the purpose of incorporating dengue fever prevention into the daily lives and education of young children, and through these students, motivating parents to become involved in source reduction activity and gradually dedicate themselves to community-based disease control, and ultimately enlarging grassroots capacity for future epidemic response. Based on the distribution of awards, the fact that the highest and second highest percentage of award winners, 100% and 86.7%, occurred in Kaohsiung County and Tainan County, respectively, highlights that the team work must have operated very smoothly with a good tacit agreement among

various bureaus of the county government, and the schools must have practiced good communication with students' parents and have strengthened students' sense of mission to participate in disease control. For large deserted containers, a considerable number of them also have been removed during community source reduction. For example, 544 pieces of canvas and 277 toilet bowls in Tainan County as well as 106 helmets in Kaohsiung County had been collected by students. Although the method of requiring students to collect containers on the way to school or bring deserted containers from their home to school in Tainan City was different from that in other counties/cities and the removed containers were not classified according to 13-category classification, this method was acceptable to the Forward Command Center and had removed as high as 110 thousand pieces of containers, having the same effect as other methods in term of source reduction. This activity supports that education is an important part in communicable disease prevention and control.

In the early stage of the source reduction campaign, it was a little bit more difficult to persuade personnel in schools to organize activity for community source reduction, compared with that for indoor or outdoor source reduction. The main reason behind this problem was that school personnel were worried about potential infection with dengue fever among student participants during the source reduction activity, which was a self-centered way of thinking. Eventually, a total of 25,483 students were mobilized and none of them was infected with dengue fever

during the activity. It was probably because that students had taken appropriate protection measures, such as using mosquito repellent and wearing long sleeve shirts and long trousers, and that the activity required the students to constantly move around. Therefore, a good pre-activity health education would be able to eliminate the worry of dengue infection. The experience from this campaign suggests that if the student-based source reduction activity could be included as part of the strategies of dengue control and prevention and performed during the non-epidemic period, it would be easier in implementation, but the indoor and outdoor source reduction activities should become a part of daily environmental cleaning activity and also could be a strategy to strengthen dengue control during the epidemic period.

It was difficult to evaluate effects of source reduction on the control of dengue epidemic because of other emergency interventions in affected villages, such as a comprehensive source reduction program and emergency spraying. However, since the source reduction campaign had led to the removal of a huge amount of possible breeding containers, its implementation could be a model in developing plans for future dengue control.

Acknowledgement

We would like to express our special gratitude to relevant agencies in Kaohsiung City, Kaohsiung County, Tainan City, and Tainan County, and their staff for their contribution to and cooperation in the implementation of the source reduction program.

References

1. Gubler DJ. Resurgent Vector-Borne Diseases as a Global Health Problem. *Emerg Infect Dis* 1998;4(3):442-50.
2. Richards SL, Ghosh SK, Zeichner BC, et al. Impact of Source Reduction on the Spatial Distribution of Larvae and Pupae of *Aedes albopictus* (Diptera: Culicidae) in Suburban Neighborhoods of a Piedmont Community in North Carolina. *J Med Entomol* 2008; 45(4):617-28
3. Koh KW, Ng LC, Kita Y, et al. The 2005 Dengue Epidemic in Singapore : Epidemiology, prevention and Control. *Ann Acad Med Singap* 2008;37(7):538-45
4. Tuan YC. Hung MN, Chen MJ, et al. Outbreak experience and data analysis of locally-acquired dengue fever cases in the Kaohsiung City-Kaohsiung County-Pingtung County (K-K-P) region during 2006. *Taiwan Epidemiol Bull* 2008; 24:2-20.

The 2010 Executive Report for Dengue Fever Prevention and Control in Southern Taiwan and Health Education Strategies

Hui-Ping Huang; Wei-Siang Jhao
Li-Li Ho; Shi-Hao Liu

Public Relations Office, Centers for Disease
Control, Taiwan

Abstract

The incidence of domestic dengue fever increased continuously in October 2010 in southern Taiwan. The confirmed domestic

dengue fever cases had stretched in five southern counties/cities. In respond to the dengue fever outbreak, the “Central Epidemic Command Center of Dengue Fever” was established by the Executive Yuan from October 21st to December 31st. The strategies for dengue fever prevention and control were implemented by the command center. Both directors of the Department of Health and the Environmental Protection Administration assumed the lead positions. Also, an Incident Command Post was established in southern Taiwan in order to supervise and direct the implementation of primary epidemic prevention and control measures.

The primary methods of controlling the dengue fever outbreak were “reducing the number of containers” and “eradicating mosquito vectors” in communities. For example, checking the environmental sanitation of the command center buildings, including abandoned buildings, in order to prevent mosquito breeding. The command center also intensely cooperated with local governments, encouraged the public to actively check environmental sanitation around their houses, especially mosquito breeding sites, and to implement the cleaning steps -- “check, empty, reduce, and clean” in daily life in order to maintain community sanitation.

Success in controlling dengue fever outbreak requires health education among the public through mass media and effective community cooperation. The purpose of health education is to ensure the public aware of the disease, as well as compliance with epidemic prevention measures. During the period of October 21st to December 31st, the

health education strategies included dissemination of educational materials in local areas, education of the public through mobile media, distribution of educational materials through internet, distribution of educational materials at schools, and building a website for sharing experiences about controlling epidemic dengue. For different health education strategies, the modification and integration of these strategies should be taken into consideration in order to maximize the effect of health education. In addition, people in southern Taiwan from different target populations would be able to understand the epidemic prevention measures and be willing to follow the measures through integrated health education.

Key words: dengue fever, health education strategies, reducing the number of containers

Introduction

Beginning in July 2010, imported dengue fever cases started increasing. There were 52 cases in August which was the highest case number in a month [1]. In the ranking of imported countries, Indonesia has the most cases, Cambodia the second, and then Thailand and Vietnam. Taiwan CDC surveillance data showed that Indonesia, Cambodia, Malaysia, Thailand, Vietnam, and the Philippines, are epidemic areas for dengue fever. Some of the above countries had more severe epidemics in 2010 than 2009.

For domestic dengue fever outbreaks in Taiwan, domestic cases with four different types of dengue virus appeared in Kaohsiung City between March and September 2010.

Although each type of dengue virus occurred in previous years, more than two types of dengue outbreaks within one county seldom occur (Tainan City: type 1, 3, and 4; Tainan County: type 1, 3, and 4; Kaohsiung City: type 1, 3, and 4; Kaohsiung County: type 2 and 3; Pingtung County: type 2 and 3). If the government cannot immediately control the outbreak at this situation, the risk of getting dengue hemorrhagic fever is going to dramatically increase. Also the public should have a high awareness of dengue fever outbreaks in order to prevent infection and dengue hemorrhagic fever through repeated exposure to different types of dengue virus.

Dengue fever outbreaks are highly related to environmental sanitation. Checking environmental sanitation around houses, reducing the number of containers to prevent mosquito breeding, and enhancing personal protection measures to prevent mosquito bites are important ways for the public to prevent and control of dengue fever infection and for the government to control dengue fever outbreaks. In addition, to patients with fever, physicians should evaluate carefully whether they are infected with dengue fever or not. If a patient is suspected, physicians should notify the health authorities to prevent other people from being infected. Because there were lots of heavy rain and frequent floods caused by typhoons in 2010 in the south of Taiwan, people should pay more attention to cleaning both indoor and outdoor water containers, trash, and waste to prevent mosquito breeding. Dengue fever outbreaks do not only occur in the south. People living in the other areas also have to eliminate mosquito habitats to prevent outbreaks.

Before setting up the central command center, Taiwan CDC has carried out a phone interview survey between October 8-10, 2010, to people 18 years old and higher in five southern counties/cities. The survey consisted of 1,138 effective responses. The selection bias was $\pm 2.96\%$ at 95% confidence interval. The survey showed that people in the south are low in the recognition of the severity of dengue hemorrhagic fever and not well alert to the danger of dengue fever outbreaks. People believe the main reasons to dengue fever outbreaks are “not eliminating mosquito breeding sites” and “bad environmental sanitation in public areas”, and they anticipate the government to “eradicate mosquito vectors” and “clean the environment” [2].

Therefore, the project of health education strategies for people in the south focuses on “reducing the number of containers” and “eradicating mosquito vectors”. The project provides the public immediate and correct epidemic prevention information, enhances the awareness of dengue fever outbreaks, improves the compliance of outbreak prevention measures among the public, control of dengue fever outbreaks in the southern areas, and prevents the deaths of dengue hemorrhagic fever in Taiwan. Through a two-way communication with the public, the government clarifies the measures of epidemic prevention, gains trust from the public, and shows a professional image to the public.

Strategies and Methods

Strategy One: Disseminate educational materials in local areas

Dengue fever prevention requires the

cooperation of communities and the compliance of the public. A positive attitude towards dengue fever prevention is more important than just the knowledge. Propagating the prevention measures through interpersonal communication is better than through mass communication [3]. Moreover, the support from the head of a village or a neighborhood affects the result of epidemic prevention and control. The measures of strategy are as follows:

- A. Develop the health educational materials, such as “reducing the number of containers – knowing 13 common mosquito breeding containers”. Publish the materials in the newspapers (local edition), and print them out as A4 size fliers to propagate the dengue fever prevention measures in southern Taiwan.
- B. Create slogans of “reducing the number of containers – the 13 common containers”, and make educational videos and radio broadcasts. The tapes were broadcasted not only by the Government Information Office but also by the local governments (local TV stations and FM radio stations) in southern Taiwan.
- C. The local news department of the Government Information Office produces a radio program on the local radios in southern Taiwan. The host calls out to the representatives of Incident Command Post, the representatives of county or city government public health bureau, the heads of villages or neighborhoods etc., in order to educate people by port broadcast.

- D. Use outdoor media which includes LED marquee (located at the train stations, the highway service stations, the hospitals, the motor vehicle offices, and the revenue service offices etc.). Also, hang posters at the Taipei train station and the Kaohsiung train station
- E. Hold the activity called “eradicating mosquito breeding sites in the five epidemic counties/cities” on November 1st in 2010 by Tainan City Government. Use resources from the heads of villages, neighborhoods, or volunteers to maintain a good environmental sanitation. Educate the public to eliminate mosquito habitats and prevent dengue fever outbreaks using the following slogan, “check, empty, reduce, and clean”.
- F. Encourage the community health centers and the health-related workplaces (companies and office locations of State-owned enterprises) to participate the epidemic prevention.
- G. Improve the communication between local health-care workers and the staff of epidemic prevention. Publish weekly “Dengue Fever News” to provide the latest information about the dengue fever outbreak and epidemic prevention measures to people living in the epidemic. Provide the latest information to the medical associations by “Circular Letter from the Command Center”, which asks physicians to pay more attention on suspicious case reporting.

Strategy Two: Educate the public through mobile media

In this digital world, information is transmitted rapidly. Mobile media is not only

easy to carry out but also provides information in the timely manners [4]. With the help from telephone companies, the government disseminates the information of the dengue fever outbreak through text messages to people living in the epidemic areas. Dengue fever is a local infectious disease; therefore, the support from local media and local officers is required. In previous experiences, the community media (mobile publicity unit etc.) and the head of a village or neighborhood have played important roles in outbreak prevention and control [5]. The measures of strategy two are as follows:

- A. Use the Chunghwa Telecom public service to send 1.2 million health education text messages to customers living in the five southern city/cities.
- B. Use mobile publicity unit (car ads and broadcasting) to disseminate the dengue fever prevention measures. The mobile schedule and the routs are designed by the Incident Command Post. Use taxi (car ads) to distribute flyers at specific sites.
- C. Provide colorful banners with Department of Health slogan to the communities and to the Department of Environmental Protection for them to display on garbage trucks in the five southern counties/cities. Provide the radio tapes for the Environmental Protection Administration for garbage truck broadcasting.

Strategy Three: Distribute educational materials through the internet

The Internet is a worldwide communication tool. Blogs, microblogs

(Facebook, Twitter, and Plurk), and Youtube, are common communication tools for internet users. Important messages can be rapidly passed to a widespread audience through high page-view numbers of portals and websites, such as "1922 epidemic Hotline" which has lots of fans and "epidemic prevention blog", by the series of clicking among internet users [6]. By regularly publishing dengue fever prevention information, internet users can get the latest news as soon as possible. The measures of the strategy three are as follows:

- A. Publish animated advertisements on portals, such as Yahoo Kimo and Chunghwa Telecom Hinet, in order to increase the click rate and to maximize the influence of prevention measures.
- B. Renew the "Dengue Fever News", the outbreak information, and the health educational materials on "1922 epidemic Hotline", on Facebook, Twitter, and Plurk regularly. Also provide the above information in an easy way. For example, use pictures or spoken languages to describe the dengue fever prevention.
- C. Share the stories occurring in the daily life of the outbreak prevention staff and share useful articles on the "epidemic prevention blog".
- D. Establish "Taiwan CDC Youtube", a media center, and upload various short health educational videos, weekly press conference videos, and news reports.

Strategy Four: Distribute health educational materials at schools

According to the "2010 reducing the number of containers project", which was designed by the Central Epidemic Command

Center of Dengue Fever, students and faculty were encouraged to eradicate the possible mosquito breeding sites in the epidemic areas. The activity, "knowing the common mosquito breeding containers", became one of the outdoor educational lessons. Through health education at schools, students not only gain basic dengue fever prevention knowledge, but also share preventive information to their family members. The interesting computer games are entertaining propaganda tools. Computer games encourage learning, create happy learning situations, and provide people chances to learn problem-solving skills in an interactive learning environment [7-8]. Therefore, one of the health education strategies is to provide the epidemic prevention computer games for schools located in epidemic areas. The measures of strategy four are as follows:

- A. With parents' consents, arrange for at least 50 students to participate in outdoor education to recognize and clean mosquito breeding containers every week.
- B. Set up a "dengue fever epidemic prevention site" on the Ministry of Education's website for the schools' reference.
- C. Integrate the health education materials on the "Central Epidemic Command Center of Dengue Fever" website to be suitable for students in different educational levels; regularly renew the website for reference.
 - a. Provide the health education materials, games, and other materials to schools for reference; send a circular letter to school as a reminder.

- b. Collect the dengue fever health educational materials from the faculties; post the materials on the “dengue fever epidemic prevention site” for reference.
- B. Add the dengue fever issues into the curriculum for students under high schools under the supervision of the Ministry of Education:
 - a. Elementary and middle schools: Strengthen the knowledge of dengue fever and enhance personal protection measures among students by teaching dengue fever prevention measures in the health science classes and the physical education classes.
 - b. High schools: Strengthen the skills to prevent dengue fever outbreaks by teaching dengue fever prevention measures in the health science classes and the nursing classes as well as by holding activities, such as competition and essay contest.
- C. Strengthen the knowledge of dengue fever prevention and the health education among students and faculty: Use Taiwan CDC posters, electronic bulletin boards, and LED marquees in schools under the supervision of the Ministry of Education. Use the parents’ meetings, the weekly meetings, and the class meetings, to remind students and parents to enhance personal protection measures, to check environmental sanitation around their houses, to reduce open collections of water, and to eradicate outbreak sources in order to control the outbreak.
- D. Use mass media to propagate: propagate the dengue fever prevention measures through a radio program called “school

health notes” , which is produced by the National Education Radio.

- E. Propagate the health education strategies in the meetings of the Ministry of Education, in health-related meetings in colleges, and in health-related meetings of local governments.
- F. Integrate and post student health educational materials, including online games, children’s short stories, and e-books, on the “Central Epidemic Command Center of Dengue Fever” website or on the “dengue fever epidemic prevention site” as reference for people to download.

Strategy Five: Build a website for sharing the experiences of dengue fever outbreak prevention and control.

The new educational materials which are developed by the command center could be posted on the website. The purpose of strategy five is to share experiences and to avoid repeatedly posting the same information.

- A. Post the health educational materials on the health education site of the command center’s website.
- B. Create different educational discs based on different target populations (e.g., the school version, the local community version, and the hospital version); disseminate the discs to organizations, associations, and local governments to propagate the epidemic prevention measures.

Methods

Selecting different strategy combinations based on different target populations could

not only educate people by existing methods but also create an atmosphere of outbreak prevention in society to maximize the effectiveness of health education.

A. Different target populations:

- a. The public: the residents in the five counties/cities with dengue fever outbreaks,
 - b. The head of a village or a neighborhood (dengue fever outbreak areas only): the members in the local associations,
 - c. Schools (dengue fever outbreak areas only): the students and the faculties in the elementary schools and in the middle schools,
 - d. Health workers and the members participating in epidemic prevention: the medical association staff and the local epidemic prevention staff,
 - e. Local media workers: electronic media, print media, broadcasts, and other online journalists.
- B. The strategies of health education among each target population:
- a. The public:
 1. Educate the public about epidemic dengue fever prevention by mass media, such as electronic media, print media, and outdoor media.
 2. Send messages about epidemic dengue fever prevention through internet-based communication methods and social networking tools such as Blog, Twitter, Plurk, and FaceBook etc.
 3. Provide an emergency 24 hour telephone service, “1922”, to the public for case reporting and outbreak consulting in Chinese, Taiwanese, and Hakka.

b. The head of a village or a neighborhood:

1. The office: Epidemic prevention staffs provide some educational materials in the office for local people to get easily.
2. The community bulletin board, broadcasting system, and assemblies: Educate local people through community resources.

c. Schools:

1. Administrative system: implement the project of “reducing the number of containers” in school, hold dengue fever prevention seminars, and then provide epidemic prevention related products.
2. Radio stations: talk about special topics on the educational radio stations and in advertisements.

d. Health workers and the members participated in epidemic prevention:

1. Provide the latest information and epidemic prevention measures by posting “dengue fever news” on the command center website every Tuesday.
2. Provide the latest information to medical associations by “correspondences from the command center”.

e. Local media workers:

1. Exchange opinions by discussing special topics in epidemic prevention.
2. Provide correct epidemic prevention information through regular or temporary press conferences.
3. Correct and clarify false reports in a timely manner.

Discussion and Conclusions

In order to evaluate the successfulness of health education strategies, the command center did a second phone interview among people over 18 years old in the five southern counties/cities between December 3rd and 5th 2010. The number of effective responses was 1,125. The selection bias was $\pm 2.98\%$ at 95% confidence interval [9]. According to the knowledge about containers in the “reducing the number of containers” project (Table 1), there were 93.4% (n=1,051) of the respondents who indicated that bottles and cans are the most common water collecting containers for mosquito breeding. Used tires are the second most common containers (91.2%, n=1,026). For non-traditional containers, there were more than 60% of the respondents who believed that cooling towers (72.5%), waste canvas (69.5%) and betel nut stands (63.7%), were common sources of dengue fever outbreak. The above results show that the health education strategies are successful.

Because the incidence of dengue fever had decreased, less people worried about the dengue fever outbreak in the second phone interview (44%) compared to the first phone interview (48%). For dengue fever prevention measures, 84.9% (n = 955) of the respondents complied with the government policy to clean up unnecessary containers. Among those 15.1% of the respondents not complying with the policy, 70.0% of the respondents indicated that there were no water containers around their houses. Both of the above data show that the public have a high willingness to follow the government policy. In the public’s point of view, 77.1% of the respondents believed that the dengue fever outbreak was under control and the incidence of dengue fever had decreased. The main reason for the decrease might be people in the community eradicating mosquito habitats with the government’s help. The second reason might be the success of the integrated health education strategies (75.6%), and the application of insect repellent (73.8%). The study results show that most of

Table 1. The knowledge about containers in the “reducing the number of containers” project among respondents (n=1,125)

Containers	No.	Percentage (%)
Bottles and cans	1,051	93.4
Used tires	1,026	91.2
Water tanks	934	83.0
Waste laundry machine	886	78.8
Styrofoam	831	73.9
Candy box	745	66.2
Used toilet	877	78.0
Canvas	782	69.5
Aquarium	840	74.7
Used helmets	832	74.0
Abandoned betel nut stands	717	63.7
Cooling towers	816	72.5
Buckets, pots, plates, ladles	984	87.5
Unknown/Refused to answer	13	1.2

the public agree that the eradication of the mosquito vector is the most effective way to prevent dengue fever outbreaks, and the public believe that the health education strategies are useful.

For the sources of gaining dengue fever related information (Table 2), there were 74.3% (n=836) of the respondents indicating that they obtained information about dengue fever prevention from TV News and advertising. The percentage of people obtaining related information from newspapers was 33.6%, and then government agencies (15.2%) and Internet / Web site or newsletter (12.4%). Compared to data from the first phone interview (11.9%), the percentage of people obtaining information about dengue fever prevention from government agencies is higher. In addition, the difference in the percentage of government agencies between these two surveys was higher than the difference in the percentage of government agencies between the first survey (0.9%) and the fifth survey (1.8%) of the project, “the information sources of H1N1” between 2009 and 2010

among people over 18 years old. The above data show that the public feel the strong cooperation between the government and the local communities in the dengue fever prevention.

In this dengue fever prevention project, the assistance from the local media was not the only reason for the success of the dengue fever outbreak control. The incident command post maximized the effect of the health education through interpersonal communication by cooperating with local communities. Moreover, holding epidemic prevention related activities in school propagates the measures of dengue fever prevention and encourages the students and the faculties implementing the epidemic prevention measures in daily life, such as reducing the number of containers. According to the evaluation of the dengue fever prevention project, the respondents have higher satisfaction (74%) and confidence (76%) in the government in the second phone interview compared to that of the first phone interview (61%, 70%). The above data shows that the government obtains a positive feedback from the public.

Table 2. The information sources of dengue fever prevention, 2010 (n=1,125)

Sources	No.	Percentage (%)
TV News / Advertising	836	74.3
Newspapers	378	33.6
Government agencies	171	15.2
Internet / Web site or newsletter	140	12.4
Posters / leaflets	108	9.6
Radio News / Advertising	105	9.3
Garbage truck with stickers and red cloth strips	103	9.2
Friends / neighbors	96	8.5
Mobile Publicity unit	71	6.3
Hospitals	69	6.1
Schools	69	6.1
Journals / Books	41	3.6
Marquee in public areas	13	1.2
Taxi advertising	4	0.4

The best way to prevent dengue fever is having a good environmental sanitation in the communities. Reducing unnecessary containers is the first step, which prevent dengue fever outbreaks by eliminating mosquito habitats. Therefore, “reducing the number of containers” is one of the epidemic prevention measures in the project. Through the health education, students gain the basic knowledge of dengue fever prevention since they are young, and people in the communities implement the epidemic prevention measures in their daily lives. In the future, the government should not only focus on health education during the epidemic periods but also do it regularly in schools. In addition, each community could have an epidemic prevention association to help people not only reducing the number of containers around their houses, but also to clean basements, gutters, eaves, and other uncommon mosquito breeding sites. It would be more efficient to prevent an outbreak for the government when people keep doing these epidemic prevention measures in daily life.

Acknowledgements

We are thankful to the assistance and the support from the officers at the Central Epidemic Command Center of Dengue Fever, the Environmental Protection Administration, the Government Information Office, the Ministry of Education, and Gallup Inc. throughout the study. Gallup Inc. is the executive agency of the “2010 Epidemic Prevention Policy Survey, Centers for Disease Control, the Department of Health, the Executive Yuan”.

References

1. TWCDC. Dengue Fever –Press Releases: Travelers to Southeast Asia should prevent mosquito bites during the epidemic period. – update. Available at: <http://www.cdc.gov.tw/ct.asp?xItem=30326&ctNode=977&mp=130>
2. TWCDC. 2010 The project of public opinion survey on epidemic prevention -2010 The report of first public opinion survey on dengue fever prevention. 1st ed., 2010.
3. Hong ZY. The difference between mass communication strategy and interpersonal communication strategy for enterovirus outbreak prevention in schools-using Le-Li elementary school as an example. 1st ed., Master thesis, Graduate School of Educational Communications and Technology, National Taipei University of Education, 2006.
4. Yeh WM. How new portable media player can create the impact of intelligence property? 2007 Taiwan Academy for Information Society Annual Conference and Thesis Presentation Conference, Nov17, 2007.
5. Lu KY. A study of perceptions of and responses to inundation disasters by flood-prone area residents - using Si-Jhih flood - prone area as an example. 1st ed., Master thesis, National Dong Hwa University, Department of Natural Resources and Environmental Studies, 2004.
6. Liu HW. An explanation of blogs’ high page by using Schutz’s three types of social distribution of knowledge. 2007 Taiwan Academy for Information

- Society Annual Conference and Thesis Presentation Conference. Nov.17, 2007.
7. Chiu FH, Chen CC. The effects of students' learning in a web-based learning environment with metacognitive strategies. *Chinese Journal of Science Education*, 2002; 10(3):261-86.
 8. M V, G K. On the usability and likeability of virtual reality games for education: The case of VR-ENGAGE. *Computers & Education* 2006;50(1): 154-78.
 9. TWCDC. 2010 The project of public opinion survey on epidemic prevention -2010 The report of second public opinion survey on dengue fever prevention. 1st ed.,2010.
-