Taiwan Epidemiology Bulletin

Biweekly April 20 , 2010 / Vol.26 / No.8

Evaluation on Preparedness Plan for Influenza Pandemic in Taiwan Local Governments in 2008

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Abstract

In order to understand the influenza pandemic preparedness of local governments and provide feedbacks on the preparedness plan through the evaluation activities, Taiwan CDC, therefore, conducted an overall and comprehensive evaluation on the preparedness level of the Preparedness and Response Plan for Pandemic Influenza in local governments, provided them reference and modification, to gradually promote their preparedness levels. The evaluation shows that although 25 counties/cities have worked on the Preparedness and Response Plan for Pandemic Influenza, there is room for improvement in the overall preparedness of the plan and the level of preparedness. There is wide variation, a 40% difference between counties/cities in terms of preparedness. Among the eight strategic categories, i.e. emergency response mechanism, surveillance, community-based infectious disease prevention, use of antivirals, management of personal protection equipments, healthcare preparedness, risk communication, and continuity of local government operation; the emergency response mechanism registered the highest level of preparedness in local governments, and continuity of local government operation recorded the lowest level of preparedness. In addition, the risk communication is the one with the largest difference in preparedness. Since pandemic influenza has a wide variety of impacts to the whole society, it is not a simple issue can be dealt with by a single health department. Therefore, we recommend that the future evaluation should be in a more perspective and broader thinking so that local governments could be directed to incorporate various departments and to develop a full-dimensional plan.

Keywords: influenza pandemic, evaluation on preparedness plan, local government

INSIDE

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 : Hsu-Sung Kuo
Editor-in-Chief : Min-Ho Lai
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 2010;26:[inclusive page numbers]

Introduction

Three influenza pandemics have occurred in 20th century and caused large numbers of deaths and serious economic impacts [1]. Given the emergence of human cases of avian influenza A (H5N1) since 2003, many countries have constituted their preparedness plans for potential pandemic of H5N1 in response to the repeated warning from World Health Organization (WHO). Some countries have even further conducted evaluation and inspection on the preparedness plan in local administrative districts within the countries. [2].

Naturally, Taiwan could not except herself out of the world trends and has also actively undertaken the preparedness against the potential threats of pandemic influenza. In the level of central government, the Centers for Disease Control (Taiwan CDC) has started to proceed its preparedness on various issues since December 2003, such as the establishment of the National Influenza Pandemic Preparedness Plan (Preparedness Plan), Influenza Pandemic Strategic Plan (Strategic Plan), and Influenza Pandemic Response Plan (Response Plan). Furthermore, all of these plans were updated in accordance with the newly revised plan and guidance published by WHO. In addition, in order to examine the preparedness level of these plans, Taiwan CDC has invited Dr. Richard Coker, a scholar of the London School of Hygiene and Tropical Medicine, University of London, to evaluate the Influenza Pandemic Strategic Plan in 2007. Afterwards, the plan was improved and corrected in reference to the suggestions provided by the evaluation.

At the level of local governments, each county and city has completed their own Preparedness and Response Plan for Pandemic Influenza in October 2005, and updated the plan according to the yearly revised Strategic Plan and Response Plan published by Taiwan CDC. In order to understand the preparedness level of the plan in local governments, Taiwan CDC, therefore, conducted an overall and integrated evaluation on preparedness of the plan and sent feedbacks to local governments for their reference to correct the plan and gradually enhance the preparedness level.

Materials and Methods

A. Materials

1. The Preparedness and Response Plan for Pandemic Influenza 2008 produced by 25 counties/cities.
2. The Table of Self-Inspection Checklist for the Preparedness and Response Plan of Local Governments. This checklist was developed on the basis of the content and guidance formulated in the Response Plan, which includes eight strategic categories and 54 operating objectives. The

descriptions for each of the strategic category are summarized as follows:

(1)Response Mechanism (including 6 operating objectives)

The most important part in effective mobilization is establishment of response mechanism. Since the emergency response for pandemic outbreak involves various governmental and non-governmental sectors, not simply limited to the units of health and medical care, local governments should actually establish cross-departmental mobilization mechanism, in addition to developing an implementation plan and allocating budgets [3]. Moreover, the Response Plan should be incorporated with Emergency Operation System, specify the role and the missions for involved personnel in different departments, and establish an emergency communication network.

(2)Surveillance (including 11 operating objectives)

Disease surveillance is the first strategy at the heart of the national plans for fighting pandemic influenza, which aims to early detect cases in order to prevent epidemics from spreading. In practice, the focus of the disease surveillance system should be modified and adjusted in parallel to the findings on virological epidemiology [4]. Therefore, local governments, in reference to the focus work of disease surveillance specified by Taiwan CDC at different epidemic phases, should construct their own workflows on topics such as disease surveillance, case notification, epidemiologic investigation, specimen sampling, and specimen transportation. Moreover, a further detailed work description for each of the topic should be provided for personnel working in disease control. In addition, the Preparedness and Response Plan should include non-periodical check on the awareness of case definition and notification mechanism of novel influenza A (H5N1) cases among hospitals or clinics.

(3)Community-based Infectious Disease Prevention (including 10 operating objectives)

Community-based infectious disease prevention is the third defense line at the national plans for fighting pandemic influenza. When the epidemic could not be prevented from the measures of containment abroad and border control, and spread to the community, the strategies of patient isolation, contact quarantine, and increasing social distance (also known as non-medical public health intervention) will be very important for control of epidemic in the community. Application of these strategies before vaccine is developed may interrupt or delay the spread of epidemic [5]. Therefore, local governments, based on the available resources and regional characteristics, should establish their own flowchart for implementing the control measures of patient isolation and health self-management, prepare quarantine facilities in advance for contacts unable to stay home for self-management of health, and develop measures ahead of time for implementing the intervention of increasing social distance (such as closure of public places, closure of schools, and restriction of domestic travel), to avoid resident complaints and to control the epidemic effectively. In addition, local governments should cooperate with relevant organizations and other resources in the community to recruit and train volunteer workers for assisting the community to maintain its daily life needs.

(4) Use of Antivirals (including 8 operating objectives)

The use of influenza antivirals is the third strategy of the national plans for fighting pandemic influenza. Antivirals can be used for both treatment and prophylaxis of influenza cases. Therefore, the antivirals have the function to mitigate the spread of epidemic in addition to shortening disease course, decreasing the occurrence of serious complications, and reducing fatality rate [6, 7]. However, given the limited resources and for avoiding the abuse of antivirals, Taiwan CDC has set priority of using antivirals [3]. Local governments, based on the priority, are required to develop a plan about the antivirals distribution and management mechanism, track the use and stockpile of antivirals, and institute plan pertaining to the distribution and management procedures of antivials for mass prophylactic use.

(5) Management of Personal Protection Equipments (including 3 operating objectives)

Personal protective equipments (PPEs), including surgical mask, N95 respirator, isolation gown, and disposable coverall, are important protective equipments to healthcare workers involving the service of infection control and treatment of an isolated patient [8]. Considering the sudden increase in demand for PPEs during pandemic influenza, the preparation and sufficient stockpile for PPEs and an emergency distribution plan for them should be completed in advance. Therefore, local governments should estimate the amounts of PPEs for pandemic and stockpile appropriate number of them, establish a mechanism to check the stockpile of them in hospitals, and construct an emergency supporting system for dealing with a shortage of PPEs.

(6) Healthcare preparedness (including 8 operating objectives)

Because human has no immunity to new type of influenza virus, a large number of cases may potentially occur and become a tremendous challenge to healthcare system during pandemic [9]. In order to provide medical service needed for large numbers of influenza cases occurred in pandemic, Taiwan CDC has established the Communicable Disease Control Medical Network, which has been organized to coordinate within 6 sub-networks, and designate the responsibilities of each primary healthcare facility prior to the occurrence of a pandemic [3]. Therefore, local governments should institutes emergency response measures for medical system within their own jurisdiction area, estimate the number of potential cases and the amount of available medical resources during pandemic, and construct a plan for emergency medical resources specifically for epidemic in advance. In addition, local governments need to oversee the implementation of infection control in medical facilities and launch training and exercise activities for healthcare workers.

(7) Risk Communication (including 5 operating objectives)

Risk communication has become an indispensable part in preparedness and response plan for pandemic influenza. A well-designed communication mechanism will enable stakeholders and general public understanding policies and may enhance their compliance in control measures. In addition, an effective risk communication is helpful for constructing public confidence in government's policy implementation, avoiding excessive panic and unease [10]. Therefore, local governments should establish cooperative channels with local public media, organize appropriate dissemination materials and channels based on various needs and problems of different target population, and specify key information needed to communicate with public in different phases of pandemic.

(8) Continuity of Local Government Operation (including 4 operating objectives)

The purpose of this strategy is intended to establish a plan to maintain the operations of local governments and facilitate them to continuously provide core business of the public services during the pandemic period so that the government services will not be disrupted by absence of a large number of employees because of getting sick or under quarantine. Therefore, local governments should evaluate the potential impacts of influenza pandemic in each department, identify core business and key technologies, develop plan to protect the health of employees, deliberately formulate a human resource plan, and perform practice drills for these plans.

B. Methods

1. Local governments first completed the revision of the Preparedness and Response Plan for Pandemic Influenza by October 31, 2008, next performed a paper-based self-evaluation by filling out the Self-Inspection Checklist for the Preparedness and Response Plan of Local Governments, and finally sent the completed form to Taiwan CDC for the first and second round evaluation.

2. The scores of evaluation were calculated by using the operating objective as a score unit. The scores for calculation were arbitrarily assigned as follows:

(1)When the operating objective does not include any sub-title, in case the content of the objective has been completely planned by local government, the objective is classified as "completed" and obtain 2 scores; in case the content has not been planned, the objective is classified as "not completed" and obtain 0 score; in case the content has been planned but it is not concrete enough, the objective is classified as "partially completed" and obtain 1 score.

(2)When the operating objective includes multiple sub-titles, in case the content of the sub-title has been planned to the level of completely meeting operating objective, the objective is classified as “completed” and obtain 2 scores; in case the content has been planned to the level of 99~50 % meeting operating objective, the objective is classified as “partially completed” and obtain 1 score; in case the content has been planned to the level of less than 50 % meeting operating objective, the objective is classified as “not completed” and obtain 0 score.

3. Level of preparedness for comprehensive preparedness, strategic categories, and operating objectives in local governments is calculated with the scores obtained from the evaluation of each operating objective by using methods as follows:

(1) Level of preparedness for comprehensive preparedness is calculated by dividing sum scores obtained from the evaluation for each of the 54 operating objective by sum scores of 54 operating objectives as they are all evaluated as “completed”, then multiplying by 100 to get a percentage.

(2) Level of preparedness for one strategic category is calculated by dividing sum scores obtained from the evaluation for the strategic category by sum scores of all operating objectives under the strategic category as they were evaluated as “completed”, then multiplying by 100 to get a percentage.

(3) Level of preparedness for one operating objective among counties/cities is calculated by dividing sum scores obtained from the evaluation for the same operating objective in each county/city by sum scores of an operating objective as they were all evaluated as “completed” in 25 counties/cities, then multiplying by 100 to get a percentage.

Results

A. Level of Preparedness for Comprehensive Preparedness in Local Governments

The highest level of preparedness is 79.6%, occurred in R county that 33 operating objectives were completed, 20 partially completed, and 1 not completed. The lowest level of preparedness is 39.8%, occurred in N county that 12 operating objectives were completed, 19 partially completed, and 23 not completed. The study shows that the level of preparedness for comprehensive preparedness in each county/city is lower than 80%, 8 counties/cities reach higher than 70% and 3 lower than 60% (Table 1). The average level of preparedness in local governments is 66.07%, 11 counties/cities are higher than average and 14 counties/cities are lower than it (Figure 1).

B. Preparedness Levels for Strategic Categories

For category of response mechanism, a total of 19 counties/cities obtain 100% at preparedness level, 4 counties/cities reach to 90%, the lowest level is 70%. For surveillance, the preparedness level for each county/city is higher than 60%, 2 counties/cities are higher than 90% and 8 counties/cities are higher than 80%. For the preparedness level of community-based infectious disease prevention, only one county/city reaches more than 80% and 11 counties/cities are lower than 60%. For the preparedness level of antivirals, only 3 counties/cities reach more than 60% and all of the rest 22 counties/cities are less than 60%. For management of PPEs, the

Table 1. Level of preparedness for comprehensive preparedness of pandemic influenza in local governments

Counties/Cities	Outcome of Evaluation			
	Completed	Partially Completed	Not Completed	Level of Preparedness（%）
R	33	20	1	79.6
J	33	19	2	78.7
A	30	23	1	76.9
V	29	24	1	75.9
P	29	23	2	75
X	29	20	5	72.2
F	31	15	8	71.3
M	26	25	3	71.3
U	25	25	4	69.4
Y	23	28	3	68.5
D	20	32	2	66.7
G	25	21	8	65.7
K	21	29	4	65.7
W	22	26	6	64.8
Q	22	26	6	64.8
I	21	28	5	64.8
B	18	33	3	63.9
L	20	29	5	63.9
C	21	26	7	63
O	16	34	4	61.1
S	18	29	7	60.2
E	17	31	6	60.2
T	24	14	16	57.4
H	14	27	13	50.9
N	12	19	23	39.8

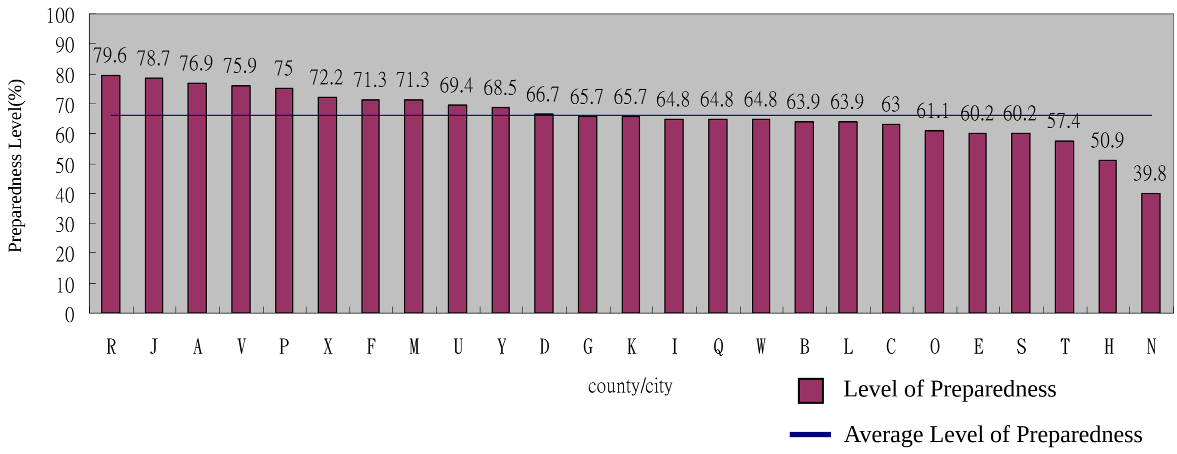

Figure 1. The comparison of level of preparedness for each county/city

preparedness level in 14 counties/cities is higher than 80% and 6 counties/cities are lower than 60%. For healthcare preparedness, the preparedness level in 7 counties/cities reach above 90% and 5 counties/cities are below 60%. For risk communication, the preparedness level in 4 counties/cities reaches 80% and 12 counties/cities are less than 60%. Only one county/city reaches more than 60% in preparedness level for continuity of local government operation (Table 2).

Table 2. Level of preparedness in local governments by strategic categories

Counties /Cities	Rseponse mechanism （%）	Surveillance （%）	Community-based infectious disease prevention （%）	Use of antivirals （%）	Management of PPEs （%）	Healthcare preparedness （%）	Risk communication （%）	Continuity of local government operation （%）
A	100	91	75	50	83	94	70	38
B	90	86	55	44	50	69	60	38
C	90	77	55	25	100	75	60	38
D	90	82	70	44	67	75	50	38
E	80	64	70	56	83	63	20	38
F	100	73	55	56	83	100	60	50
G	100	77	35	56	83	94	50	38
H	100	73	40	31	50	56	40	0
I	100	77	65	50	83	50	60	38
J	100	91	75	56	67	88	80	63
K	100	82	60	44	50	81	40	50
L	100	82	55	44	50	81	30	50
M	100	82	70	56	67	81	60	38
N	90	73	25	25	17	19	40	13
O	70	77	65	50	67	50	50	50
P	100	77	60	63	67	100	80	50
Q	100	77	50	56	33	75	70	38
R	100	86	85	56	83	94	70	50
S	100	77	50	50	83	69	0	50
T	100	77	30	56	83	81	10	13
U	100	77	33	63	83	88	80	50
V	100	73	70	56	83	100	80	50
W	100	64	65	56	83	75	50	25
X	100	86	70	63	83	100	30	13
Y	100	82	65	56	100	56	70	25

For preparedness level of strategic categories in 25 local governments (Table 3), the highest percentage, 96.4%, occurred in the category of response mechanism, among a total of 125 items of 5 operating objectives, 116 items were completed and 9 items were partially completed. The second highest percentage, 78.4%, appeared in surveillance, with 172 items completed and 89 items partially completed, and 14 items not completed among a total of 250 items of 10 operating objectives. The category of healthcare preparedness recorded the third highest percentage, 76.5%, 116 items were completed, 74 items were partially completed, and 10 items were not completed among a total of 200 items of 8 operating objectives. The category of continuity of local government function had the lowest percentage, 38%, 7 items were completed and 62 items were partially completed, and 31 items were not completed among a total of 100 items of 4 operating objectives, followed by antivirals, 50.5%, 24 items were completed and 154 items were partially completed, and 22 items were not completed among a total of 200 items of 8 operating objectives.

The overall average level of preparedness for eight strategic categories is 65.19%. Four of the eight categories recorded above the average preparedness level and four below the average level. The order of the average preparedness level of 25 local governments for the eight categories in descending order is: response mechanism, surveillance, healthcare preparedness, management of PPEs, community epidemic control, risk communication, antivirals, and continuity of

Table 3. Levels of preparedness of eight strategic categories

Categories	Outcome of Evaluation			
	Completed	Partially Completed	Not Completed	Level of Preparedness(%)
Response mechanism	116	9	0	96.4
Surveillance	172	89	14	78.4
Healthcare preparedness	116	74	10	76.5
Management of PPEs	37	33	5	71.3
Community-based infectious disease prevention	79	132	39	58
Risk communication	30	71	24	52.4
Use of antivirals	24	154	22	50.5
Continuity of local government operation	7	62	31	38

local government, respectively (Figure 2).

C. Preparedness Level of Operating Objectives

For 54 operating objectives, both the items "completing preparedness plan and assigning a specific staff to be in charge of the revision of the plan" and "specifying objectives and actions needed to be taken for the objectives in the plan" for the strategic category of response mechanism rank the highest level of preparedness at 100%, having been completed in all 25 counties/cities. The item "clearly describing roles and responsibilities of relevant personnel" for the strategic category of response mechanism and both the items "establishing notification procedures and communication channel based on the standard operation procedures defined in Notification of Communicable Disease System" and "planning emergency response measures for sampling and investigation of suspect H5N1 cases" for the strategic categories of surveillance all registered the second highest level of preparedness at 96% (completed in 23 counties/cities and partially completed in 2 counties/cities). The lowest level of preparedness at 26% occurred in the item "performing practice drills on issues of human resource management and functional operation" for the strategic category for continuity of local government , which is completed in one county/city, partially completed in 11 counties/cities, and not completed in 13 counties/cities. The second lowest level of preparedness at 32% occurred in the item "assigning specific staff to be in charge of the information system operation for antivirals management" of the strategic category for antivials, which is partially completed in 16 counties/cities, and not completed in 9 counties/cities. This is followed by, 34%, the level of preparedness of the item "completing the plan of maintaining important facilities function" for the strategic category of continuity of local government operation, only one county/city is completed, 15 counties/cities partially completed, and 9 counties/cities not completed (Table 4).

The overall average level of preparedness for 54 operating objectives is 66.14%. The number of items that higher than average is 24, and 30 items are lower than average. The analysis shows that those items in the category of response mechanism registered the highest overall average level, each item is above the average preparedness level, and those in category of risk communication and category of continuity of local government operation recorded the lowest level, all items are below the average (Figure 3).

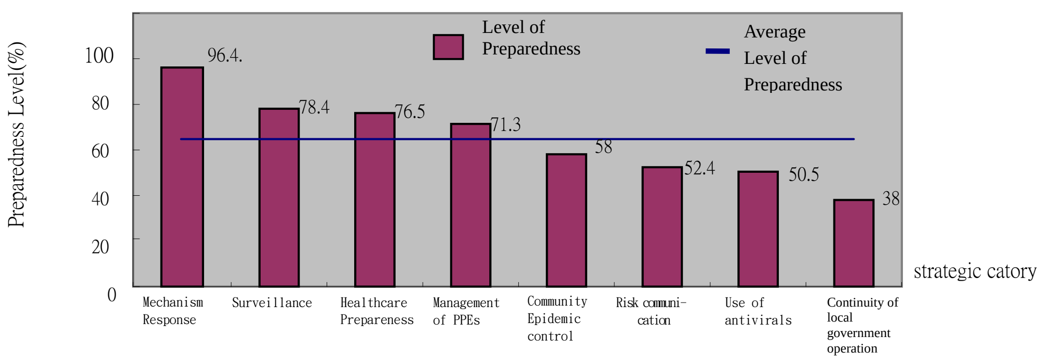

Figure 2. The comparison of level of preparedness for each strategic category

Table 4. Levels of preparedness for each of 54 operating objectives

Items of operating objective	Outcomes of Evaluation (N=25) Completed	Partially Completed	Not Completed	Level of Prepared-ness（%）
Response Mechanism				
1-1*	25	-	-	100
1-2*	25	-	-	100
1-3**	21	4	-	92
1-4	22	3	-	94
1-5	23	2	-	96
Surveillance				
2-1	22	3	-	94
2-2*	23	2	-	96
2-3	22	2	1	92
2-4*	23	2	-	96
2-5	14	10	1	76
2-6	8	15	2	62
2-7	17	7	1	82
2-8**	5	15	5	50
2-9**	2	21	2	50
2-10	19	5	1	86
2-11	17	7	1	82
Community-base Infectious Disease Prevention				
3-1	6	17	2	58
3-2	15	9	1	78
3-3	12	7	6	62
3-4**	4	13	8	42
3-5	2	18	5	44
3-6	1	21	3	46
3-7	12	10	3	68
3-8	3	18	4	48
3-9*	20	3	2	86
3-10	4	16	5	48

Items of operating objective	Outcomes of Evaluation (N=25) Completed	Partially Completed	Not Completed	Level of Prepared-ness（%）
Use of Antivirals				
4-1	3	21	1	54
4-2	6	19	-	62
4-3	-	23	2	46
4-4**	-	16	9	32
4-5*	13	10	2	72
4-6	-	22	3	44
4-7	2	21	2	50
4-8	-	22	3	44
Management of PPEs				
5-1**	10	13	2	66
5-2*	14	10	1	76
5-3	13	10	2	72
Healthcare Preparedness				
6-1	19	5	1	86
6-2	9	15	1	66
6-3	14	11	-	78
6-4	14	10	1	76
6-5*	21	4	-	92
6-6	11	11	3	66
6-7**	9	12	4	60
6-8	19	6	-	88
Risk Communication				
7-1	5	15	5	50
7-2	9	11	5	58
7-3*	12	8	5	64
7-4	3	18	4	48
7-5**	1	19	5	42
Continuity of Local Government Operation				
8-1	1	15	9	34
8-2*	5	16	4	52
8-3	-	20	5	40
8-4**	1	11	13	26

*The items of operating objective with the highest level of preparedness; **The items of operating objective with

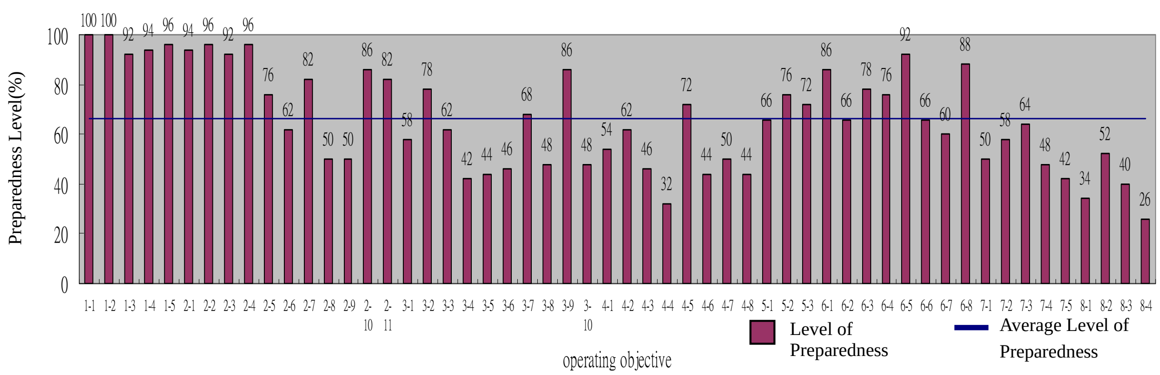

Figure 3. The comparison of level of preparedness for each operating objective

Discussion

A. Existing wide variation in preparedness level among local governments and room for improvement.

This study shows that although 25 local governments have worked on the Preparedness and Response Plan for Pandemic Influenza, there is room for improvement in the overall preparedness of the plan. The level of preparedness among local governments exist wide variation, a 40% difference between the highest and lowest level of preparedness. This study also found that local governments that have a higher level of preparedness are usually conduct evaluation on various issues with potential risk and analysis on the topics probably with insufficient capacities, and then deliberately formulated the items of objectives and actions for the plan on the basis of the evaluation and analysis. However, there still are some local governments that developed plan neither incorporating substantial contents nor working toward their own specific characteristics but copied paragraphs from the Response Plan. There are even very few local governments that have missed contents in describing one of the categories of the strategy in their plan.

B. A well-organized response framework has been established for influenza pandemic based on experience in Emergency Disaster Response.

This study found that response mechanism is the category with the highest average level of preparedness among eight strategic categories in local governments. The reasons for this outcome are probably that the plan and operation framework for emergency response to the more frequently occurred various natural disasters have been well-established and performed empirically for years in local governments. Therefore, most counties/cities are capable to construct a complete operation framework, specify roles and responsibilities for each department, and develop a list of emergency contact information based on experience in Emergency Disaster Response. Some local governments have even created a response mechanism for potential H5N1 human cases, including notification process and activation mechanism for emergency response to influenza epidemic in avian. These mechanisms will be useful in the integration of information on human and avian influenza epidemic.

C. Continuity of local government operation is a new issue and its preparedness still needs to be promoted.

Continuity of local government operation is the category with the lowest average level of preparedness among eight strategic categories. This phenomenon may result from the fact that because maintaining continuity of government operation during the period of influenza pandemic is a newly recognized issue that counties/cities did not have clear concepts about the risk that influenza pandemic is likely to interrupt the operation of governments. Therefore, most local governments did not develop their own plans for maintaining continuity of government operation. They simply made the plan by directly copying the corresponding parts from the Response Plan.

D. Plan for release of risk communication message should be established.

As mentioned in the previous section that variation of the preparedness levels among local governments is different from each other. Among the eight strategic categories, the risk communication ranked the largest variation among them. Some well-planned counties/cities have already set the implementation process for message release and have established multiple channels with local media groups for message communication. This finding is similar to that obtained from the evaluation to 56 states and administrative districts in the United States in 2008, the majority of administrative districts also have already planned the message release procedures and established pertinent communication channels [2]. However, some counties/cities have only described the principles or general rules for conducting risk communication on various key issues. They did not specify the target population to whom key message will be disseminated and measures for key message dissemination on the basis of locally existed characteristics and of different epidemic phases. This situation may need a lot of time in dealing with these problems in case influenza pandemic really happens.

E. Standard operation procedure established for surveillance by central government could be as a reference to local governments.

Surveillance is the strategic category with the least difference in preparedness among counties/cities. The possible explanation for this finding is that various uniformed national guidance for surveillance and specimen sampling have been established by central government and have been used by local governments for years, so most local governments have become familiarized with these standard operation procedures and know how to apply them to develop the plan for pandemic surveillance.

F. The management of antivirals use needs to be improved.

The management of antivials use is the strategic category with the second lowest level of preparedness for local governments, and the item "familiarity with the operation of antivirals management system" recorded the lowest preparedness level among its operating objectives. We speculate that the unfamiliarity to the management system may result from several factors, such as with only a few cases meeting the criteria of using antivirals in recent years, without assigning specific personnel in charge of operating the management system in majority of counties/cities, and a high turnover rate of the operation personnel. In addition, some counties/cities completed their plans by just copying contents about the distribution of antivirals for prophylactic use from the national plan, lacking substantial action plan and failing to reflect specific local demands and characteristics.

G. Plan for community-based infectious disease prevention is still insufficiently established.

Community-based infectious disease prevention is one of the strategic categories with a lower level of preparedness in local governments. One possible reason is that it is a relatively new concept, so most health personnel are unfamiliar with its application to disease control. The majority of local governments did not consider planning pertinent quarantine facilities for people who are unsuitable to stay home for home quarantine, such as travelers, dormitory residents, and homeless people. In addition, it also needs to be improved regarding the integration of existing community volunteer organizations and pre-defining missions and responsibilities for these organizations on the basis of their specific characteristics, so that the community resources could be bonded together for effective implementation of community-based infectious disease prevention.

H. Items for evaluation should be increased more broadly and deeply.

The items chosen for evaluation were formulated on the basis of the Response Plan. However, the items included in the evaluation checklist seems less broader as compared with the version created by US Department of Homeland Security in 2009 for the evaluation on pandemic preparedness of 56 states and administrative districts, which contains items related to infrastructure service such as food and energy supply. Therefore, items chosen for evaluation should be expanded in both width and depth.

I.The document-based evaluation probably produces an outcome different from on-site evaluation.

The preparedness evaluation in this study was conducted simply on the documents related to the preparedness plan provided by local governments but not implemented through on-site observation. Since the real situation of the preparedness in local governments may partially different from the contents described in plan, the evaluation outcomes may be unable to totally reflect the real preparedness level.

J. Feedback on the evaluation should be sent to local governments instantly for immediate correction

The preparedness evaluation in this study was conducted through a self-evaluation process by local governments plus a first and second round evaluation by Taiwan CDC. The whole process is not only labor-intensive and time-consuming but also unable to instantly send feedback on the evaluation to local governments for their immediate correction.

Conclusions and Suggestions

A. This study shows that there is room for improvement in the preparedness of the current plan in some local governments. In addition, the local governments with a higher preparedness level could be considered as an example for learning and improvement for those with lower level. Therefore, this evaluation even has the function of providing mechanisms for group learning.

B. Although the evaluation helps us understand the completeness and drawback of the preparedness plans in local governments, it takes time for implementation. Therefore, we suggests that in the future a more economic way for evaluation should be considered, such as conducting evaluation through internet. By this way, local governments will be able to check and evaluate the preparedness of the plan by their own at any time and to receive instant feedback.

C. Since pandemic influenza has a wide variety of impacts to the whole society, its consequences are not simple issues can be dealt with merely by a single health department. Therefore, the items included in the evaluation should be considered with more perspective and broader thinking so that local governments could incorporate various departments and to develop a full-dimensional plan. Moreover, the plan should be tested for its feasibility by performing exercise and simulation drills and be continuously revised based on the exercise experience to make the plan more complete and practical.

D. The countries in the world have always considered the influenza A (H5N1) strain as a potential virus most probably causing worldwide pandemic since 2003 and took it as a virtual enemy for combating in developing their preparedness and response plan. However, the strain causing worldwide pandemic since April 2009 was novel influenza A (H1N1) virus. Since influenza virus evolves in a rapid and unpredictable way, the preparedness plan and its evaluation items should be modified to be suitable for using in various pandemic caused by different types of influenza virus.

E. The preparedness for a pandemic is a dynamic process rather than a statically unchanged status. The preparedness currently in place may need to be changed with the times and may be different from the version of the moment being evaluated.

References

1. Kilbourne ED. Influenza pandemic of the 20 th century. Emerg Infect Dis. 2006; 12:9-14.
2. Homeland Security Council**.** Assessment of States' Operating Plans to Combat Pandemic Influenza Available at: http://www.mrw.interscience.wiley.com/cochrane/clsysrev/articles/CD004404/frame.html
3. Taiwan CDC. Influenza Pandemic Strategic Plan. 2nd version. 2008.
4. WHO. WHO consultation on priority public health interventions before and during an influenza pandemic. Available at: http://www.who.int/csr/disease/avian_influenza/consultation/en/index.html
5. WHO Writing Group. Non-pharmaceutical interventions for pandemic influenza, national and community measures. Emerg Infect Dis. 2006;12:81–7.
6. WHO. Avian influenza: assessing the pandemic threat. Available at: http://www.who.int/csr/disease/influenza/H5N1-9reduit.pdf
7. Monto AS. Vaccine and antivialss in pandemic preparedness. Emerg Infect Dis. 2006;12:55-60.
8. Occupational Safety and Health Administration U.S. Department of Labor. Pandemic Influenza Preparedness and Response Guidance for Healthcare Workers and Healthcare Employers. Available at: http://www.osha.gov/Publications /OSHA_pandemic_health.pdf
9. PandemicFlu.gov. What is influenza pandemic? Available at: http://www.pandemicflu.gov/general/whatis.html
10. WHO. WHO Outbreak communication guidelines. Available at: http://www.who.int/infectious-disease-news/IDdocs/whocds200528/whocds200528en.pdf

Dengue Vector Breeding Sites Inspection and Ovitrap Monitoring in and around the Gymnasiums and Stadiums of World Games 2009 in Kaohsiung, Taiwan

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Abstract

The World Games 2009 was held in Kaohsiung during July 16-26, 2009. Knowing many participating athletes, team members, spectators and visitors from all over the world would come to Kaohsiung City and County, Taiwan CDC established a Dengue Task Force three months prior to the World Games to prevent dengue outbreak. The task force studied dengue vector density and vector breeding sites in 27 competition venues (including four practicing fields) and their surroundings. In addition, the ovitrap monitoring program was conducted in June and July 2009 to intensify the surveillance of dengue vector density, by placing ovitraps in the 22 competition venues of the World Games.

The program of mosquito breeding site inspection and ovitrap monitoring initiated by Taiwan CDC, with the full cooperation and mobilization of Kaohsiung City and County governments, have victoriously eliminated the density of dengue mosquito throughout the gymnasiums and stadiums of 2009 World Games and also have delayed the occurrence of the first indigenous dengue cases in summer season, successfully completing the missions for this period.

Keywords: World Games, dengue fever, mosquito breeding sites, ovitrap, Dengue Task Force

Introduction

Kaohsiung City and County are located in tropical zone and are considered as a high risk area for dengue epidemic. In this area, there have been dengue outbreaks in different level of severity every year since 1987. Over the last ten years, two large-scale dengue epidemics have occurred in 2002 and 2006, leading to a number of 4811 and 942 indigenous cases, respectively. In 2002, dengue outbreak first emerged in Cianjhen District of Kaohsiung City, then, spread to the adjacent Fengshan City, and finally extended to other neighborhoods, including Pingtung County, Tainan City, and Penghu County, etc. Seven counties and cities were involved and 5336 indigenous cases were identified around the country in the end. Thereafter, dengue epidemic occurred periodically in Kaohsiung areas and became a major public health issue for local citizens.

By definition, mass gathering is an event attended by more than 1000 persons at a specific location for a specific purpose within a defined period of time [1]. In a major sporting event, because a large amount of athletes, on-site workers, and audiences are gathering together in a limited space within a short period of time, pathogens may be quickly transmitted via direct contact, air droplets, or vectors in the gymnasiums and stadiums, practice fields, medical station, or audience section, and eventually cause cluster infection. During the 1991 International Special Olympics Games, a large-scale measles infection spread promptly in the mass gathering event [2]. According to an assessment report about public health risks for the Athens 2004 Olympic Games, foodborne and waterborne diseases posed the highest risk to public health, followed by airborne diseases, such as influenza, tuberculosis, meningitis, pertussis, measles, and Legionnaires' disease, especially within the indoor venues [3].

In order to provide athletes, referees, and audiences from different countries with a healthy environment, and to avoid the potential occurrence of dengue epidemic during the World Games 2009 in Kaohsiung, Taiwan Centers for Disease Control (Taiwan CDC), based on the Article 15 of the Communicable Disease Control Act, organized a Dengue Task Force in March 2009 to conduct a thorough study for dengue vector density and breeding sites in 27 gymnasiums and stadiums, practice fields, and their surroundings. Since no positive breeding container was found and no adult *Aedes* mosquito was caught in some of the stadiums or gymnasiums during the first five sections of inspections, the implementation of breeding sites inspection and reduction in these areas was took over by related management units.

In addition, previous study indicated that ovitraps can be used as a tool to intensify the surveillance of mosquito density in areas with low breeding site density or even without positive breeding site [4]. Singapore started using ovitraps for monitoring *Aedes* mosquito density in 2000 to identify hotspots or risk areas where there is a danger of high *Aedes aegypti* infestation [5]. Therefore, Taiwan CDC placed ovitraps in the 22 competition venues of the World Games since June 2009 to monitor dengue vector density. This study summarized the procedures and results of the dengue vector breeding sites inspections and surveillance throughout the gymnasiums and stadiums of the World Games.

Materials and Methods

The inspection of vector breeding sites was implemented by inspectors of the Dengue Task Force that was composed of members from Second Division and other Branches of Taiwan CDC. In practice, the inspections were divided into several sections by time, three days each. The first two sections were implemented by three groups, two members each, during March 24-27 and April 14-16, 2009, respectively. Afterwards, the inspections were performed in a two-week interval for the third, fourth, and fifth sections. However, since no positive breeding container was found and no adult *Aedes* mosquito was caught in some of the stadiums or gymnasiums during the first five sections of inspections, the implementation of breeding sites inspection and reduction in these areas was took over by related management units. Therefore, only two groups of inspectors were needed from the sixth sections. As of July 9, 2009, a total of eight sections of inspection have been completed and 126 person-days have been mobilized.

When a breeding site was found during inspection and needed to be further tracked for improvement, the inspectors would upload its photographs and improvement requests to the Mosquito-Breeding Site Management System of Taiwan CDC for monitoring. As for a major breeding site or those failed to comply with requests, an Inspection and Supervision Notice would be issued. And Kaohsiung City and County governments would supervise the associated units to improve it within a limited time period.

The ovitrap monitoring program was initiated on June 4, 2009. Ovitraps were placed in selected sites after on-site evaluation in 23 gymnasiums and stadiums on June 4-5. The gymnasium located at I-Shou University, however, was not included in the monitoring program since it is too far away from other competition sites. The ovitraps were checked for the first time on June 15 and then examined weekly. To the week that the Opening Ceremony of World Games was held on July 13, a total of five examinations have been completed.

There were six ovitraps in each of the 22 gymnasiums and stadiums. Three of them were placed in the indoor area and the rest were placed in the outdoor area. The three ovitraps in the same site were made in different ways. One of them has a breeding stick inside it, one has a sticky paper, and the other has both breeding stick and sticky paper. The distance among the three ovitraps was no more than one meter.

In principle, the breeding stick and sticky paper were collected and renewed on every Monday. The collected breeding stick and sticky paper were sent to Research and Diagnostic Center of Taiwan CDC and its contract partner, National Pingtung University of Science and Technology, to hatch eggs, rear larvae and identify mosquito species. All the results from the ovitraps survey were provided as a reference for disease control.

Results of Breeding Site Inspection

In this study, a total of 989 water-holding containers were found, and 76 of them were positive for mosquito breeding, including 7 (10.1%) found at indoor sites and 69 (89.9%) found at outdoor sites, with a ratio of indoor versus outdoor: 1:9. These demonstrate that the positive breeding containers were mainly occurred in outdoor locations (Table 1). Among all inspection

Table 1. Results of mosquito breeding site inspection in and around the gymnasiums and stadiums of World Games 2009 in Kaohsiung, Taiwan

Inspection Section	No. of Gym and Stadium inspected	No. of Water-holding Container			No. of Positive Breeding Container			No. of Female *Aedes* Mosquito						No. of *Aedes* Larvae			
								Aedes Aegypti			*Aedes Albopictus*						
		Indoor	Outdoor	Subtotal	Indoor	Outdoor	Subtotal	Indoor	Outdoor	Subtotal	Indoor	Outdoor	Subtotal	*A Aegypti*	*A Albopictus*	Unclasified	Subtotal
1	23	70	165	235	5	22	27	3	0	3	2	16	18	20	115	835	970
2	27	15	56	71	0	6	6	0	3	3	0	6	6	0	0	180	180
3	27	18	346	364	0	22	22	0	1	1	0	48	48	0	125	437	562
4	27	22	43	65	0	5	5	3	0	3	0	10	10	0	0	156	156
5	27	3	54	57	0	0	0	0	0	0	0	0	0	0	0	0	0
6	19	0	23	23	0	6	6	0	4	4	0	40	40	0	0	282	282
7	19	7	134	141	1	6	7	0	0	0	0	1	1	0	0	305	305
8	19	7	26	33	1	2	3	0	0	0	0	1	1	0	0	153	153
Total		142	847	989	7	69	76	6	8	14	2	122	124	20	240	2348	2608

sections, the first and third one were the two that the largest number of positive breeding containers had been found, 27 and 22 pieces, respectively. However, numbers of positive breeding containers were reduced to relatively small after the third section (Figure 1). Compared to other locations of inspection, Kaohsiung Swimming Pool had the largest number (13 pieces) of positive breeding containers, followed by Kaohsiung Museum of Fine Arts, Kaohsiung Metropolitan Park, and Chengching Lake, 9 pieces each. There were lots of positive breeding containers found at Kaohsiung Swimming Pool in the third section of inspection, but no more positive breeding containers were found afterwards. This indicated successful improvement by breeding site elimination.

In respect of numbers of *Aedes* mosquitoes captured and sites where they were caught, the results present that as many as 34 mosquitoes (30 *Aedes albopictus*, 4 *Aedes aegypti*), were found in Lotus Pond, followed by Kaohsiung Metropolitan Park (13 *Aedes albopictus*), Nanzih Archery Range (11 *Aedes albopictus*), and NSYSU Guoguang Laboratory School (10 *Aedes albopictus*). Most of these locations are either scenic spots or open space. Locations of gymnasiums and stadiums of the Wold

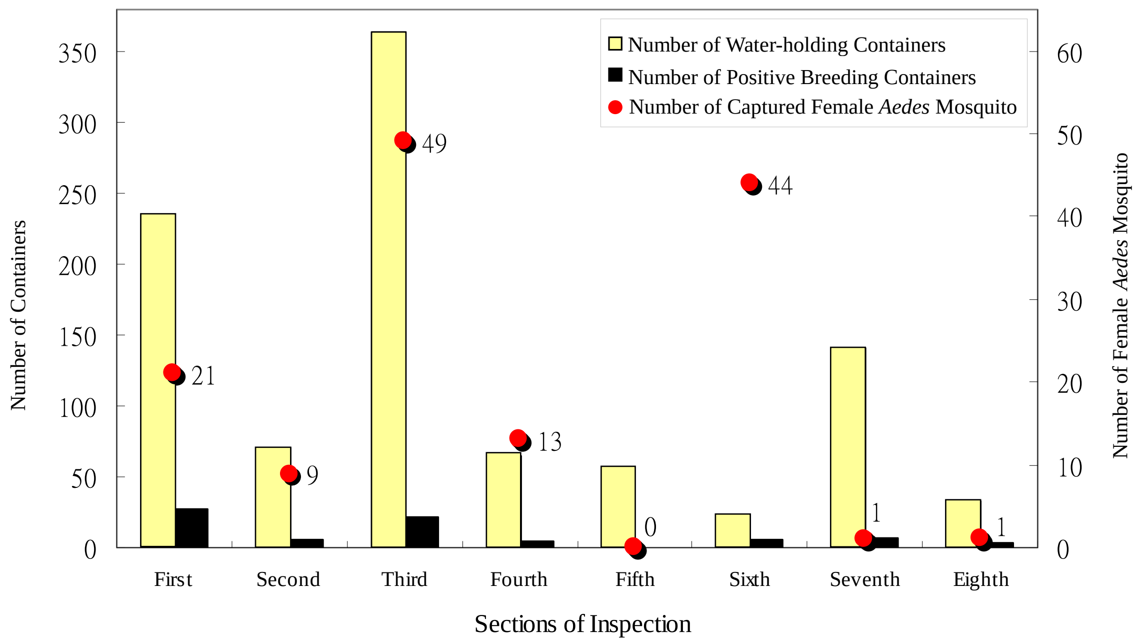

Figure 1. Number of vector breeding containers found and number of female *Aedes* mosquito caught in the inspection of the gymnasiums and stadiums of World Games 2009 in Kaohsiung, Taiwan

Games are displayed as shown in Figure 2.

During the inspection period, a total of 42 Inspection and Supervision Notice had been issued, including 35 notices for gymnasium or stadium in Kaohsiung City and 7 in Kaohsiung County. On receiving the notification from Taiwan CDC, Kaohsiung City and County governments have in turn issued an improvement notice or other written document, based on relevant regulations, to require the related units to improve the situation within a limited time period.

Results of Ovitrap Monitoring

A total of 1277 mosquito eggs were collected in 5 ovitrap examinations, the third one has the largest number of eggs (395), followed by first one (286) (Table 2). By monitoring sites, the highest number of eggs falls at Kaohsiung Museum of Fine Arts (286), the second highest number at Kaohsiung Metropolitan Park (267). In

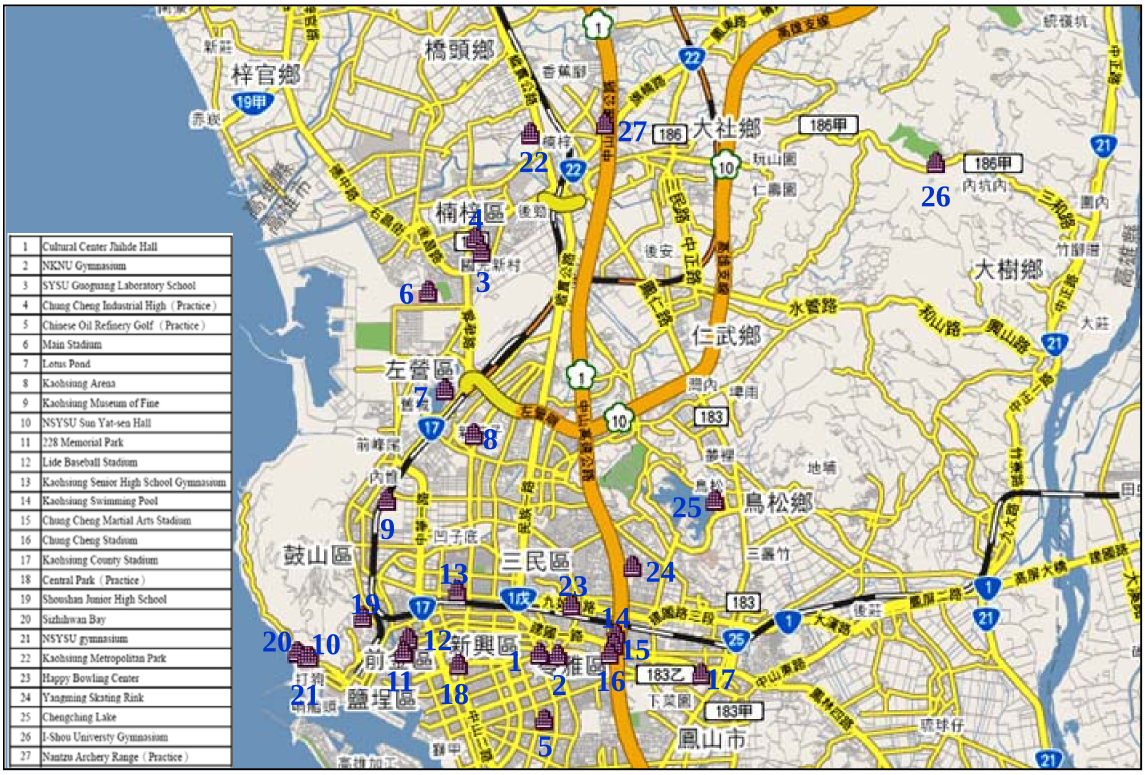

Figure 2. Geographical locations of gymnasiums and stadiums of World Games 2009 in Kaohsiung, Taiwan

Table 2. Number of eggs and mosquitoes collected from ovitraps in the competition venues of World Games 2009 in Kaohsiung, Taiwan

Examinations	No. of eggs	*Culex quinquefasciatus*			*A. albopictus*			*A. aegypti*		
		male	female	subtotal	male	female	subtotal	male	female	subtotal
1	286	62	64	126	0	7	7	0	3	3
2	167	31	33	64	0	19	19	0	1	1
3	395	2	63	65	0	19	19	0	3	3
4	193	11	9	20	0	3	3	0	6	6
5	236	4	14	18	0	7	7	0	1	1
Total	1277	110	183	293	0	55	55	0	14	14

addition, more than 100 eggs were collected at each of the following sites: NSYSU gymnasium, NSYSU Guoguang Laboratory School Gymnasium, and Kaohsiung County Stadium. All the collected eggs were obtained from the ovitraps placed outside the gymnasiums or stadiums. No eggs were found from the indoor ovitraps.

For adult mosquitoes captured from ovitraps, the species of *Culex quinquefasciatus* has the highest number (293) among various species, accounted for 81% of total number of captured adult mosquitoes. This is followed by species of *Aedes albopictus*, 55 (15%), and the species of *Aedes aegypti* has the least number among them, only 14 (4%). When the calculations were counted only for female mosquitoes, *Culex quinquefasciatus* still has the highest number among them, 183 (72%), followed by *Aedes albopictus*, 55 (22%), and *Aedes aegypti* has the least number, only 14 (6%). The result shows that both male and female *Culex quinquefasciatus* have been collected but only female *Aedes albopictus* and *Aedes aegypti* have been collected (Table 2).

The results show that the number of Aedes aegypti captured from ovitraps is similar between those inside and outside the competition venues without apparent difference. However, for Aedes albopictus, almost all of them were captured from outdoor ovitraps, accounting for 98.1% (53 mosquitoes), but only one mosquito was found from indoor ovitrap.

The analysis of site distribution for each species of captured adult mosquitoes shows that the Kaohsiung Swimming Pool had the largest number of *Culex quinquefasciatut*, then NSYSU Sun Yat-sen Hall; the NSYSU gymnasium shared the highest number of *Aedes albopictus* (26), and then few at Lotus Pond, NSYSU Sun Yat-sen Hall and 228 Memorial Park; the Shoushan Junior High School had the largest number of *Aedes aegypti* (6), next Chengching Lake (2), and then Main Stadium, NSYSU Sun Yat-sen Hall, and 228 Memorial Park (one mosquito at each of them).

The percentage of ovitraps with *Aedes* mosquito, the so-called positive ovitraps, can be calculated in two ways, by using either the number of ovitraps capturing adult *Aedes* mosquito or found with eggs as numerator. However, the latter takes a long time for the process of hatching, rearing, and species identification. In this study, the percentage of positive ovitraps was calculated directly from the ovitraps number with adult *Aedes* mosquitoes captured by sticky paper. The result shows that the percentage of positive ovitraps for indoor venues is 2.2%-4.6% and outdoor venues 11.4%-13.6%, apparently higher than indoor venues, and the average of indoor and outdoor venues 6.8-8.0% (Table 3).

Table 3. Percentage of positive ovitraps at competition venues of World Games 2009 in Kaohsiung, Taiwan

Examinations	No. of ovitrap		No. of ovitrap with adult *Aedes* mosquito			Percentage of positive ovitraps		
	Indoor	Outdoor	Indoor	Outdoor	Total	Indoor	Outdoor	Total
1	43	44	2	5	7	4.6%	11.4%	8.0%
2	44	44	1	5	6	2.2%	11.4%	6.8%
3	44	44	1	6	7	2.2%	13.6%	8.0%
4	44	44	2	5	7	4.6%	11.4%	8.0%
5	44	44	1	5	6	2.2%	11.4%	6.8%

Note: Percentage of positive ovitraps = Number of ovitrap with adult *Aedes* mosquito/Total number of ovitraps collected ×100%

Discussions

According to the statistics of the World Health Organization (WHO), 40% of world population (around 2.5 billion populations) are at risk from dengue infections. There is an estimated annual occurrence of 50 million cases of dengue fever and 0.5 million cases of more serious dengue haemorrhagic fever [6].

The factors leading to a global dengue epidemic include urbanization of residence, failing to enforce vector control, climate change, virus evolution, and increasing international travel [7]. Some studies indicated that global warming may have made the natural environment be more suitable for vector survival, causing a gradual increase in occurrence of dengue epidemic [8].

The strategies to prevent the transmission of infectious disease in a major sporting event must recognize risks at three levels of population, including the individual athlete, the team, and spectators or other who may become exposed to the infection as a result of sports-related activities [9]. According to recent statistics of Taiwan CDC, indigenous dengue fever in Taiwan usually occurred in June-July and reached the peak in October-November. Based on this data, the athletes and their teams as well as a large amount of spectators from all over the world participating in the World Games held in July are all at risk from dengue infection.

One of the key measures to prevent dengue fever is vector control. Since mosquitoes prefer places with standing water and female mosquitoes need blood for breeding, their habitats are often closely related to human residential areas. Therefore, thoroughly cleaning indoor and outdoor water-holding containers around the house has been the most effective way of dengue prevention. A study about pre-seasonal treatment showed that starting breeding sites elimination and larvae control 2-3 weeks before the onset of rainy season can apparently reduce the Breteau index of *Aedes aegypt*i. And the *Aedes aegypti* population did not return to pre-treatment level until 9-11 weeks after treatment [10]. Similarly, this breeding site inspection program was conducted to decrease dengue vector density before it reaches the peak by means of thoroughly cleaning water-holding containers and positive breeding containers, to prevent from dengue infection during the World Games.

In this study, of the 235 water-holding containers found in the first section of inspection, 27 are positive breeding containers; and 33 found in the eighth section of inspection, 3 are positive breeding containers. The number of water-holding containers decreased from 235 in the first section to 33 in the eighth section, an 86% decrease, and the positive breeding containers decreased from 27 to 3, an 88% decrease. Of the 989 water-holding containers accumulatively found in eight sections of inspection, 142 were found inside the competition venues, including 7 positive breeding containers, and 847 outside the competition venues, including 69 positive breeding containers. The analysis shows that the number of water-holding containers and positive breeding containers has been gradually reduced, as compared with those in early stage of the inspection, after the improvement and enforcement of vector breeding site reduction by local health bureaus and related management units. This supports that the periodic inspection program has achieved its purposes of clearing vector breeding sites and decreasing vector population. However, mosquito eggs and adult *Aedes* mosquito could still be detected in ovitrap monitoring conducted subsequently. This suggests that some hidden vector breeding site may have not yet been found and removed.

When most of the breeding sites and water-holding containers were cleared, ovitraps can still attract gravid female mosquitoes to lay eggs and, therefore, capture other mosquitoes from hidden places. WHO also recommended using ovitraps as a more sensitive and economical monitoring tool in areas where the density of Aedes mosquito is low (Breteau index less than 5) [4].

The disadvantage of ovitraps is that it can not reflect the species and numbers of breeding mosquito immediately because the eggs needed to be hatched and the larvae needed to be reared under specific laboratory conditions until the third and fourth larval stage for species identification. The whole process usually takes more than one week [11]. Therefore, some researchers have modified ovitrap by placing a sticky paper inside it to capture adult mosquitoes. This modified ovitrap has the advantage that the species of captured mosquito can be directly and rapidly identified, as compared with traditional ovitrap. The drawback of the modified ovitrap is that glue on sticky paper may lose its function because of moisture when the ovitrap is placed outdoor in rainy days. As a result, the outcome of ovitrap monitoring may be underestimated [12-14]. The modified ovitrap has been used in Australia for monitoring of *Aedes* mosquitoes. Through the capture of gravid female mosquito by sticky paper, it apparently reduced the time for species identification and positive rate calculation and also enhanced monitoring efficiency [13].

The ovitraps used in this study is identical to those used in the Study of Ovitrap Monitoring for Dengue Vector conducted by Taiwan CDC. A breeding stick and sticky paper are both equipped in the ovitrap so it can be used to monitor the density of larvae and adult mosquito simultaneously. A cover has also been placed over the ovitrap to prevent from rain water, which may affect the results if raining.

Ovitrap monitoring shows that the places where mosquito eggs were collected are not consistent with those adult *Aedes* mosquitoes were captured. Moreover, because the hatching rate of eggs collected at some competition venues is very low, the species and number of mosquitoes obtained from these sites may be unable to represent the real mosquito density. The number of *Culex quinquefasciatus* and *Aedes albopictus* captured by sticky paper inside ovitrap is apparently lower in the fourth and fifth examinations (during June 29 – July 13, 2009). This result could be associated with the indoor and outdoor insecticide spraying conducted by Kaohsiung City government at all competition venues during the same period of time (July 1-13, 2009). However, since insecticide spraying can only kill adult mosquito but has no effect on larvae, dengue control will ultimately rely on implementation of clearance of vector breeding sites. Previous study found that although insecticide spraying could promptly lower down the density of adult Aedes mosquito, the density was returning to pre-spraying level at 7-9 days after spraying. Therefore, insecticide spraying has only a very limited long-term effect on dengue control [15]. To maximize the efficiency, the strategy of insecticide spraying for dengue control in Taiwan is that unless there is a risk of transmission, the insecticide will not be applied [16].

The percentage of positive ovitraps in this study is 6.8-8.0%. According to the mosquito density indicator used by other country, it belongs to the level (with a range of positive ovitraps rate 5-20%) of that although vector is existed, there is no danger of large-scale dengue outbreak [17]. This result supports that the vector breeding site inspection program performed since March, 2009 has yielded a significant effect on decrease of mosquito density in each of the competition venues. In addition, the ovitrap monitoring program launched in the middle of inspection program has also provided an excellent tool in surveillance. In other words, the combination of these two programs has provided the World Games participants a healthy environment without dengue infection. To the date of July 26, 2009 when the World Games is ended, no indigenous dengue cases have been identified.

Conclusions

The program of mosquito breeding site inspection and ovitrap monitoring activity initiated by Taiwan CDC, with the full cooperation and mobilization of Kaohsiung City and County governments, have victoriously decreased the density of dengue mosquito throughout the gymnasiums and stadiums of 2009 World Games and also have delayed the occurrence of the first indigenous dengue cases in summer season, successfully achieving the goals for this period.

Acknowledgement

The authors would like to acknowledge colleagues from Branches and Research and Diagnostic Center of Taiwan CDC for their participation in program implementation and assistance in offering relevant information.

References

1. DeLorenzo RA. Mass gathering medicine: a review. Prehospital Disaster Medicine, 1997;12:68–72.
2. Ehresmann KR, Hedberg CW, Grimm MB, et al. An outbreak of measles at an international sporting event with airborne transmission in a domed stadium. J Infect Dis 1995;171:679-83.
3. Hadjichristodoulou C, Mouchtouri V, Soteriades ES, et al. Mass gathering preparedness: the experience of the Athens 2004 Olympic and Para-Olympic Games. J Environ Health 2005;67:52-7.
4. WHO. Guidelines for Dengue Surveillance and Mosquito Control. 2003:19.
5. Ginny Tan Ai-leen and Ren Jin Song. The use of GIS ovitraps monitoring for dengue control in Singapore, Dengue Bulletin, 2000;24:110-6.
6. WHO. Guidelines for Dengue

Surveillance and Mosquito Control. 2003:1.

7. Guzman MG, Kouri G. Dengue: an update. Lancet Infect Dis 2002;2:33-42.
8. WHO. The World Wealth Report. Life in the 21st Century: a vision for all. 1998:1.
9. Goodman RA, Thacker SB, Solomon SL, et al. Infectious diseases in competitive sports. JAMA 1994;271:862-7.
10. Chadee DD. Impact of pre-seasonal focal treatment on population densities of the mosquito *Aedes aegypti* in Trinidad, West Indies: A preliminary study. Acta Trop. 2009;109:236-40.
11. Focks DA. A review of entomological sampling methods and indicators for dengue vectors. TDR IDE/DEN; 2003:40.
12. Rawlins SC, Martinez R , Wiltshire S, et al. A comparison of surveillance systems for the dengue vector *Aedes aegypti* in Port of Spain, Trinidad. Am Mosq Control Assoc. 1998;14:131-6.
13. Ritchie SA, Long S, Hart A, et al. An adulticidal sticky ovitrap for sampling container-breeding mosquitoes. Am Mosq Control Assoc. 2003;19:235-42.
14. Ritchie SA, Long S, Smith G, et al. Entomological investigations in a focus of dengue transmission in Cairns , Queensland , Australia , by using the sticky ovitraps. Med Entomol 2004; 41:1-4.
15. Reiter P, Gubler DJ. Surveillance and control of urban dengue vectors. In: Gubler DJ, Kuno G, editors. Dengue and dengue haemorrhagic fever. Wallingford, oxon: CAB International, 1997;425-62.
16. Wang JH, Wu JW, Liu DP, et al. Benefit evaluation of dengue adult mosquito chemical control and its application. Taiwan Epidemiol Bull 2009;25:391-99.
17. The Government of the Hong Kong Special Administrative Region, Food and Environmental Hygiene Department. Dengue Fever Ovitrap Index Update. Available at: http://www. fehd.gov.hk/english/safefood/dengue_fever/ovitrap_index.html