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An Investigation of the Risk Factors of a Dengue Fever Outbreak in Sanmin District, Kaohsiung City, 1998

Abstract

Four types of dengue viruses have appeared in Kaohsiung City since the outbreak in 1987. By December 7, 1998, the number of confirmed cases of indigenous dengue fever of the 1998 outbreak had accumulated to 52, forty (77%) of them in Sanmin District. Laboratory testing by Center for Disease Control confirmed the agent to be type Ⅱ dengue virus. To understand the outbreak, to study the risk factors involved in inter-household infection of dengue fever, and thus to formulate effective control measures, a retrospective cohort epidemiological study was conducted. Of the 83 households interviewed, 11 had at least one member of the family meeting the definition of a confirmed case. Two households had at least one member meeting the definition of a suspected case. The household attack rate was then estimated at between 13.3% (=11/83) and 15.7% (13/83). In the 13 households, there were 24 cases, 13 males (54.2%) and 11 females (45.8%). Their ages ranged 5-65 years, averaging 35.6±15.6 years, with a median of 38.5 years. Major clinical symptoms were fever (24 cases, 100%), rash (22, 91.7%), and headache (20, 83.3%). 23 of them (95.8%) had been treated; two (8.3%) were hospitalized. The average period between the onset of symptoms and treatment was 0.61±1.44 days (ranging 0-5 days). In terms of

risk factors, it was found that more cases clustered in households with increase in the size of household. By adjusting interfering factors with multivariate analysis, it was noted that piled junk in basement (OR=11.160, 95% confidence interval at 1.183-105.240), outdoor bonsai (OR=1.112, 95% confidence interval at 1.001-1.234), and presence of screened windows (OR=0.162, 95% confidence interval at 0.030-0.869) were statistically significant.

Introduction

Taiwan, being in the subtropical zone with high temperature and humidity, is more appropriate for the breeding and growth of organisms including hazardous organisms such as mosquitoes, flies, cockroaches, fleas, and rats. They serve as media for pathogenic microbes to infect humans with life-threatening diseases. Dengue fever is one of the diseases. There have been four major outbreaks of dengue fever in Taiwan before the Second World War. It was not until 1981 when another major outbreak of dengue type Ⅱ virus occurred in Liuchiu Township of Pingtung County. Another major outbreak occurred in the Kaohsiung area during October 1987 and end of 1988. The attack rate of the adult population in Kaohsiung City of this outbreak was estimated at 5.6%[(1)]. There have been sporadic infections since then. Of virus types, type Ⅰ was more prevalent in outbreaks before 1994; since 1994, various virus types have infected more areas. In 1995 for instance, virus types Ⅰ, Ⅱ, Ⅲ, and Ⅳ concurrently induced infections. In the Kaohsiung area, virus types Ⅱ, Ⅲ, and Ⅳ were isolated at the same time[(2,3)]. In the 1998 outbreak in Kaohsiung City, virus types Ⅰ, Ⅱ, Ⅲ, and Ⅳ were isolated concurrently. Confirmed indigenous dengue fever cases has been reported in Kaohsiung City since August 1998. By December 7, the number had accumulated to 52, forty (77%) of them in Sanmin District. Laboratory testing by Center for Disease Control showed that virus type Ⅱ was isolated in 17 of the specimens tested. At the same time, there were 14 imported cases in Kaohsiung City, three (21%) of them in Sanmin District. The present investigation initiated to understand the nature of the outbreak, to identify likely risk factors, and thus to draft effective control measures for the reference of future control programs.

Materials and Method

1.Questionnaire Survey

A cross-sectional study method was used in the investigation to interview with a structured questionnaire residents of all households in the Tingchin neighborhood of Sanmin District, Kaohsiung City, in the blocks along Tienhsiang First Road, Tingchin Rear Road, Lane 41 of Tingchin Rear Road,

and Tinghsin Road. The questionnaire contained items in three parts: personal background information in Part 1; history of dengue fever infection, illnesses in the last three months and clinical symptoms, medical care, health conditions of other members of the family, and findings of laboratory testing in Part 2; and structure of the house, with or without screened windows, environmental sanitation in and out of the house, sources of breeding, with or without bonsai, and personal hygiene in Part 3.

2.Laboratory diagnosis

(1) Capture IgM ELISA: Each microtiter well was coated overnight at 4oC with 5μg/ml, 100 μl/well of goat IgG (Fab'2) against Human IgM. After washing with PBS-0.1% Tween 20 (PBST), wells were blocked with 200 μl of PBS-1% BSA for 1 hour at 37oC and incubated with 100 μl of 1:100 diluted sera for 1 hour at 37oC in PBST-1% BSA. Then, a virus mixture containing 15 HA units each of four types of dengue viruses (DEN-1 Hawaiian strain, DEN-2 New Guinea C, DEN-3 H-87 and DEN-4 H-241 strains) were added and incubated for 1 hour. After washing, 100 μl of 1:1000 diluted D2-56.3 ascites was added and incubated for 1 h at 37oC. The Affinity-purified goat anti-mouse IgG-alkaline phosphatase (Jackson) conjugate at 1:10,000 dilution was added and incubated for 1 hour at 37oC after washing. Finally, the enzyme activity was developed with the addition of substrate p-nitrophenyl-phosphate (Sigma) and readings were taken at the dual wavelengths of 405 and 570 nm with a Dynatech MR700 microplate reader. Specimens were considered positive when their OD 405 values were higher than the cut-off value.

(2)Hemagglutination-inhibition (HI) test: Serum was pretreated with acetone and 100% goose RBC in 56℃ water bath for thirty minutes to remove nonspecific hemagglutination inhibition factor and nonspecific hemagglutin respectively. The absorbed serum was two fold serially diluted and 0.025 ml serum were added into 96 well microtiter plate, followed by 8 HAU/0.025 ml/well virus antigen. This mixture were incubated for 18-21 hours at 4℃, then 0.05 ml 0.33% goose RBC is added and incubated for 1 h at 56℃ before reading the result.

(3)Isolation of Virus: Serum of cases within 7 days after the onset of disease was taken and cultured for 7 days in C6/36 or AP61. ATCC HB114 monoclonal antibody capable for identifying dengue virus was used for IFA (indirect immunofluorescent assay). The positive ones were further determined their dengue virus types by type-specific monoclonal antibodies (ATCC HB47, 46, 49, 48).

(4)RT/PCR (reverse transcriptase polymerase chain reaction): 140 μl of serum was collected from case within 10 days after the onset of disease. QIAamp HCV Kit was used to extract virus RNA. 35 μl of RNA was taken as template, to be mixed with consensus primer capable of adhering to all four types, and under the joint action of RT (reverse transcriptase), DNA polymerase, dNTP, and specific saline to perform RT-PCR. 1/10 of the end product was taken for nested PCR with type specific primers. Some of the end product was taken and placed for electrophoresis on agarose gel for reading. Length of the first reaction was 511 bp; the second reaction was DEN-1 482bp, DEN-2 119bp, DEN-3 290bp, DEN-4 392b0. (supplied by Center for Disease Control)

Primer sequences

		product length
(1)consensus primers		
D1(G)	5'-TATGCTGAAACGCGAGAGAAA-3'	
D2(C)	5'-TTGCACCAACAGTCAATGTC-3'	511bp
(2)type specific primers		
TS1(C)	5'-CACCTCAGTAATTCGAGGACAT-3'	482bp
TS2(C)	5'-CGCCACAAGGGCCATGAACAG-3'	119bp
TS3(C)	5'-TAACATCATCATGAGACAGAGC-3'	290bp
TS4(C)	5'-CTCTGTTGTCTTAAACAAGAGA-3'	392bp

3.Definition of Case

Definition of suspected case: An individual who demonstrated one of the following two symptoms in the period between August 1 and December 11, 1998, 1) fever of 38^0C, and complications of severe headache, retroorbital pains, and bone, joint and muscle pain; or 2) rash 3 to 4 days after onset of fever, and itching, though not confirmed serologically or virologically, was defined as a suspect.

Definition of confirmed cases: In addition to the clinical symptoms of a suspect, a confirmed case must meet one of the following criteria: 1) from whose clinical specimens dengue virus was isolated; 2) RT-PCR positive; 3) sera collected at any time were dengue virus IgM antibody positive and Japanese encephalitis IgM antibody negative; 4) dengue fever HI antibody potency of sera in convalescence period was equal or more than four times higher than that of the acute period. A case was defined an imported case if he/she went abroad three days to two weeks before the onset of disease.

The cases studied in the present investigation included both the confirmed and the suspected cases. The rest members of the households were made the controls.

4.Meteorological Data

Meteorological data published by the Central Weather Bureau for 1998 for Kaohsiung City on temperature, rainfalls, and relative humidity were analyzed for their monthly average temperature, the lowest average temperature, and cumulative rain falls to study the relationship between changes in weather and the number of dengue fever cases.

5.Survey of the Density of Dengue Fever Vectors

50 households in one neighborhood from each district were selected by the health department for the survey of larva breeding. Density of the Aedes larvae was expressed by the Breteau index.

6.Data Analysis

Questionnaire information was placed on Epi-info 6.0 software and verified for each variable. As there was often family clustering of dengue fever cases, in the analysis of risk factors, only one positive case out of one or more positive cases in a family was selected for study. For controls, one individual of all uninfected individuals was selected for study. They were compared of differences in risk factors. Odds ratios and 95% confidence intervals were calculated to study the relationship between each variable and the occurrence of dengue infection. In univariate analysis, χ^2-test and Fisher's exact test were used to study if differences in categorical variables between cases and controls were statistically significant. ANOVA and t-test were used to study if the continuous variables were statistically significant. In multivariate analysis, stepwise multiple logistic regression analysis was used to adjust the interfering factors.

Results

In the blocks along Tienhsiang First Road, Tingchin Rear Road, Lane 41 of Tingchin Rear Road, and Tinghsin Road of Tingchin neighborhood, there were 122 households; of them, 83 were successfully interviewed, giving an interview rate of 68%. In the 83 households, 11 had at least one person meeting the definition of a confirmed case; two had at least one person meeting the definition of a suspected case. The household attack rate was estimated at between 13.3% (11/83) and 15.7% (13/83).

There were altogether 24 cases in the 13 households, 13 males (54.2%) and 11 females (45.8%). They aged between 5 and 65, averaging 35.6±15.6 years, with a median of 38.5 years. The major clinical symptoms were fever (24 cases, 100%), rash (22, 91.7%), headache (20, 83.3%), itching (15, 62.5%), muscle pain (15,

62.5%), loss of appetite (13, 54.2%), joint pain (15, 62.5%), nausea (4, 16.7%), vomiting (3, 12.5%), waist pain (5, 20.8%), retroorbital pain (1, 4.2%), neck pain (3, 12.5%), dry mouth (3, 12.5%), bleeding gums (2, 8.3%), back pain (2, 8.3%), and weary tongue (1, 4.2%). 23 of them (95.8%) were medically treated; and two hospitalized (8.3%). The average time between the onset of symptoms and medical treatment was 0.61±1.44 days (ranging 0-5 days).

In terms of the risk factors of dengue infections, it was noted that more cases clustered in families with increase in the size of households. However, in the groups in which the family size was more than ten members, the number of cases was too few to be of any significance (Table 1). In the univariate analysis of household structure, in 4 out of 13 in the case groups and 7 out of 70 in the control groups, piled junk was found in the basement. Their relative odds ratio of 2.91 (95% confidence interval at 1.08-7.85) was statistically significant ($p<0.05$). 4 in the case groups and 42 in the control groups had screened windows. Their relative odds ratio was 0.36 (95% confidence interval at 0.12-1.07), p-value being 0.051. In terms of outdoor activities, activities in the house and around school made significant differences ($p<0.05$), indicating that these two places were risk factors of dengue infections (Table 2).

By applying multivariate analysis to adjust interfering factors, it was noted that only three factors, piled junk in basement, outdoor bonsai (and on the balcony), and presence of screened windows were statistically significant ($p<0.05$). Of them, the screened windows were a protecting factor, their odds ratio was 0.162 (95% confidence interval at 0.030-0.869). Piled junk in basement and the number of outdoor bonsai were risk factors; their odds ratios were 11.160 (95% confidence interval at 1.183-105.240) and 1.112 (95% confidence interval at 1.001-1.234) (Table 3).

Discussion

Dengue fever in Taiwan is a viral infection that bounces back. It is spread primarily by Aedes aegypti and Aedes albopictus. Mosquitoes infected by biting a human being transmit the infection to others by mosquito biting. Infections occur at an interval of 14-20 days[(4)]. Cases, therefore, must be immediately identified, mosquitoes killed, and breeding sources eliminated to minimize the number of infected persons in each occurrence to effectively control the infection.

By December 11, 1998, the number of cases meeting the definition of a confirmed case increased to 58, including one dengue hemorrhagic fever case. The first confirmed indigenous case was reported on September 11 in Tingli neighborhood. Symptoms were fever, pains, loss of appetite, rash, and itching. Subsequently, more cases were identified in the neighboring Tingchiang and Tingchin neighborhoods. It can be noted from the epidemic curve of the present

outbreak (Figure 1) that the outbreak began in early September, reaching its peak on November 8 through 14 with 19 cases (31.6%). More cases were identified in the four neighboring neighborhoods in the northern part of the City, 28 cases (47%) in Tingchin, 19 (31.6%) in Tinghsi, 5 (8.3%) in Tingli, 4 (6.7%) in Tingchiang, 2 (3.3%) in Changming, and one each in Paoan and Wanli.

Figure 2 shows the relationship between weather, vector densities, and dengue infection. In the period between August and November in Kaohsiung City, the weekly cumulative amount of rainfalls was as high as 1,365 mm in the first week of August, 1,351 mm in the second week of September, and 725 mm in the second week of October. The average weekly temperature was 24-30^{0}C; still at 28^{0}C in early October; and dropped to 24-25^{0}C only after mid-October. The weather report showed that the relative humidity was as high as 85% in the second week of September, 83% in the first week of August, and somewhere between 70 and 85% during August and November, a condition most appropriate for the breeding of vector mosquitoes. Surveys of vector densities by the Kaohsiung City Health Department showed that the Breteau index in the second week of October was 22, 16 in the first week of November, and 14 in the third week of November. All densities were at degrees 3 and 4. Though no vector density data were available for August and September, in Tingchin neighborhood, in a month after the peak of rainfalls when vector density was the highest, cases began to appear in early October, to reach a peak in a month after the high vector density (Figure 2). Gubler[5] maintained that rains and typhoons in summer and autumn brought about large amount of rains appropriate for the breeding and growth of Aedes larvae. Ke[6] pointed out that the density of Aedes aegypti and the amount of rainfalls were positively related to the cumulative incidence of dengue infections. The amount of rainfalls of the previous month was the best predictor of dengue infections. Koopman et al.[7] reported that the odds ratio of dengue infection was four times higher in rainy season at a temperature of 30^{0}C than at 17^{0}C. Wang et al.[8] pointed out that weather in Taiwan has become warmer recently, probably due to the effect of the global warming. This warming effect could have modified the disease transmission capability of the dengue vectors, and expanded year by year the areas of high Aedes vector density.

Dengue cases tend to cluster in families. In 1969 in Puerto Rico[9], more than three persons were infected at the same time in each family, and the findings were statistically significant. In an extreme case in a 30-member household on mainland China, 29 were infected[10]. Family clustering was also noted in epidemic areas of dengue hemorrhagic fever[11,12,13]. 413 persons lived in the 83 households of the present investigation. The individual attack rate was 5.8% (=24/413). 74 people lived in the 13 households with cases. The positive inter-familial infection rate was 32.4% (=24/74). Chances of family members

being infected became larger when there was a case in the house.

Most cases were reported from Tingchin neighborhood, 28 cases in total. Specimens were not collected from the two suspected cases for laboratory testing. Eight cases were reported by physicians; 17 by epidemiological surveillance; and one by sentinel surveillance. Center for Disease Control reported that 8 of the 26 cases were inapparant infections. The neighborhood had two clusters, one along Lane 10 of Tienhsiang Road with 13 cases (46.4%); the other, along Tingchin Rear Road with 10 cases (35.7%). The rest cases spread around (Figure 3). Therefore, Tingchin neighborhood was a typical area of clustering dengue infection. The neighborhood, old and with many people living in crowded areas, and with a high vector density of 3-4 degree (no record of dengue outbreaks in the last three years, however), was more prone to dengue infections. In particular, when there were no screened windows to keep away vector mosquitoes, and when there was piled junk in the basement and bonsai outdoors (two ideal places for the breeding of vector mosquitoes), when mosquitoes entered the house, or when there was dengue fever carrier in the house, clustering outbreaks of infection in community and in family were likely to occur.

Wu[14] reported that the dengue type Ⅱ outbreak in Liuchiu township of Pingtung County in 1981 was in summer, with major symptoms such as fever, headache, nausea, weakness, joint pain, and rash, but not itching. The present outbreak showed similar symptoms, except that 91.7% and 62.5% of cases had rash and itching respectively. This fact showed that clinical symptoms of dengue fever varied and could be taken for symptoms of other diseases. Therefore, blood specimens should be taken immediately for laboratory testing to help in the formation of control measures.

Presence of screened windows, piled junk in basement, and outdoor bonsai were some of the risk factors of dengue infection. Huang et al.[15] in their study in Kaohsiung showed that the number of water containers in and out of the house and their positive rate were a reflection of the lifestyles of the people. In Sanmin District, there were more containers of positive Aedes breeding outdoors than indoors. Empty areas had become breeding places for Aedes mosquitoes, more Aedes aegypti than Aedes albopictus. Huang[16] also pointed out that Aedes aegypti preferred staying indoors at dark places such as curtains, furniture, hanging clothes, and screens. Ko et al.[1] found that the odds of dengue infection for people in houses with screened windows was 0.58 of those in houses without screened windows. Screened windows were protective. Morens et al.[17] also found in the investigation of the 1977 Puerto Rico dengue fever outbreak that the relative odds ratio of dengue infection in houses without screened windows was

1.17 times higher against houses with screened windows. Although the peaks of Aedes aegypti biting in a day are around 9-10 a.m. and 4-5 p.m., they bite at any time of the day[18]. Female mosquitoes are easily frightened while biting. Their biting is interrupted. To have enough blood, a female mosquito has to bite more times, many people may thus be attacked at the same time. If the mosquito carries dengue virus, many members of the household are likely to be infected at the same time within 24 to 36 hours[18]. The fact that the present outbreak concentrated in two clusters in Tingchin neighborhood, and that the family infection rate of the 13 cases was as high as 32.4% seemed to correspond positively with the risk factors of infection identified in the present investigation.

The present outbreak concentrated around the area along Tienhsiang First Road. Few studies have adopted the retrospective cohort method to study risk factors of infection. This method was used the first time in the present investigation to minimize selection biases. Also, to avoid any information bias of the respondents in responding to the questionnaire, the availability of environmental exposure factors such as bonsai, water containers, ditches and others was observed by the interviewers in person. The limitation of the present investigation was that not every one in the cohort had blood specimens taken for laboratory testing, attack rates were estimated by the symptoms of suspects, they could be either over or under-estimated. Another limitation was, though efforts had been made to minimize information bias, as the area had already been sprayed and the sources of breeding eliminated by health authorities, the direct observation of the availability of environmental exposures factors could have been incomplete.

Dengue type Ⅱ virus was isolated by the RT-PCR method from the 17 confirmed cases of the 1998 dengue infection in Sanmin District. For the entire Kaohsiung City, all virus types Ⅰ, Ⅱ, Ⅲ, and Ⅳ had been detected. Studies indicated that risk factors of dengue hemorrhagic fever included types of virus strains, serotypes of virus, age and immunity of the individual, latent infections, repeated infections, and genetic factors. The four serotypes can all induce dengue hemorrhagic fever, though type Ⅱ is more likely[16]. Wu[19] in his analysis of the trends of dengue infections in Taiwan, pointed out that the infection was at the third stage of "typical dengue fever infection turning endemic, with more virus types appearing at the same time, and accidental incidents of dengue hemorrhagic fever occurring". The present outbreak seemed to meet these conditions. It was fortunate that there was only one dengue hemorrhagic fever case in Kaohsiung City in the 1998 outbreak. However, from the epidemiologic patterns of the past and the risk factors detected in the present investigation, chances of dengue hemorrhagic fever infection in Kaohsiung City are high.

Limitations of Investigation

In addition to interviewing confirmed cases and investigating outbreak in all neighborhoods of Sanmin District, the interviewers also visited some selected households in Tingchin neighborhood. Some members of the households were not met; some refused to be interviewed. Stores in the nearby market area were busy in the morning; they closed for the day soon after mid-noon. Some households, therefore, could not be interviewed. A household was used as a unit for interviewing. Though there were 28 cases in Tingchin neighborhood, they clustered in two areas. Infection rate within family was high. The number of positive households visited thus was fewer.

Recommendations

1. Community participation and mobilization of community resources should be encouraged to eliminate breeding sources of vector mosquitoes. People do not quite behave as they preach. Environmental sanitation is often overlooked. Larvae of vector mosquitoes are noticed in many houses as well. For effective control of infections and to upgrade the quality of life, it is recommended that neighborhood leaders take the initiative, with the help of volunteers, to encourage residents to clean up the environment and to eliminate the breeding sources periodically.
2. Health education should be intensified to prevent outbreaks of dengue hemorrhagic fever. People should be alerted to the danger of this infection and to take necessary precautions.
3. Physicians should be made more alert to consider the possibility of dengue infection in a person with any suspected symptoms. They should be trained in the diagnosis and treatment of dengue hemorrhagic fever as it is rarely seen in Taiwan.
4. At time of outbreak, even if there are only suspected cases, if the vector density is high, epidemiologic investigation and elimination of breeding sources should be extended to an area larger than the recommended 50-meter radius.
5. Households with cases should be made the center of epidemiologic investigation. Each member of the household, suspected or not, should have a blood specimen taken for laboratory testing to detect any inapparent cases, and thus to interrupt the infection.

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Table 1. Relationship between Family Size and Dengue Infection

Family Size	No. of Household	0 Case	1 Case	>+2 Cases
1	1	1	0 (0%)	0 (0%)
2-4	37	31	5 (13.5%)	1(2.7%)
5-9	42	35	3 (7.1%)	4 (9.5%)
>=10	3	2	1	0
Total	83	9	5	69

Table 2. Analysis of Risk Factors

Risk Factors			Cases	Controls	Relative OR	95% CI
Age+			41.5±13.1	46.1±15.5	0.96	p=0.315
Sex	female		7	33	1.00	0.80-1.16
	Male		6	37		
Education+	Primary and less		2	29		p=0.236
	Jr high		4	10		
	Sr high		6	24		p=0.853
	College and above		1	7		
Religion+	Buddhism		9	42		
	Taoism		4	25		
	Christianity		0	2		
	Others		0	1		
Basement		yes	5	15	1.97	0.73-5.34
		no	8	55	1.00	
Piled junk in basement"		yes	4	7	2.91	1.08-7.85*
		no	9	63	1.00	
Screened windows"		yes	11	63	1.63	0.40-6.73
		no	2	17	1.00	
Screend doors		yes	4	42	0.36	0.12-1.07
		no	9	28	1.00	
Water containers"		yes	1	6	0.90	0.14-5.97
		no	12	64	1.00	
Indoor water containers		yes	6	23	1.60	0.54-4.31
		no	7	47	1.00	
Indoor bonsai		yes	4	11	2.01	0.71-5.68
		no	9	59	1.00	
Outdoor bonsai		yes	8	28	2.09	0.75-5.85
		no	5	42	1.00	
Water plate in refrigerator		yes	6	21	1.78	0.66-4.78
		no	7	49	1.00	
Outdoor water container"		yes	1	4	1.30	0.21-8.09
		no	12	66	1.00	
Mosquito net		yes	1	1	3.38	0.77-14.84
		no	12	69	1.00	
Activity around house"		yes	10	29	3.76	1.11-12.69*
		no	3	41	1.00	
Around school"		yes	3	1	5.93	2.64-13.32*
		no	10	69	1.00	

+t-test
"Fisher's exact test
*p<0.05

Table 3. Multivariate Analysis of Risk Factors

	B value	Variance Coefficient	Relative Value	95%CI
Constant	-3.312	1.461		
Sex	-0.973	0.844	0.378	0.072-1.976
Education	0.401	0.422	1.493	0.653-3.413
Less outdoor activity	-1.124	0.879	0.325	0.058-1.819
With screened door	-1.818	0.856	0.162	0.030-0.869*
With screened window	1.933	1.042	6.907	0.896-53.250
Junk in basement	2.412	1.145	11.160	1.183-105.240*
Outdoor bonsai	0.106	0.053	1.112	1.001-1.234*
Indoor bonsai	1.373	0.880	3.947	0.704-22.142
Large-size water tank	-1.041	1.535	0.353	0.017-7.115

*$p<0.05$

Figure1. Epidemic Curve of the Dengue Infection

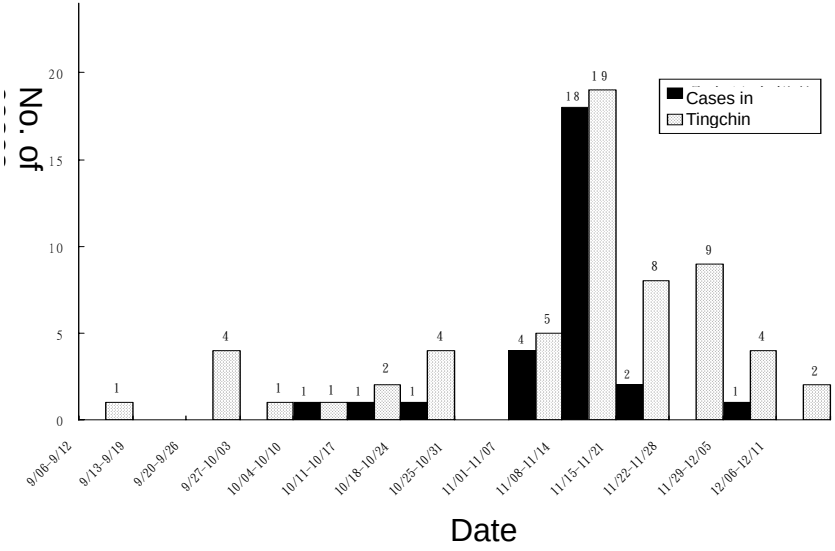


Figure2. Rainfalls, Temperature, Breteau Indexes, and No. of Dengue Cases

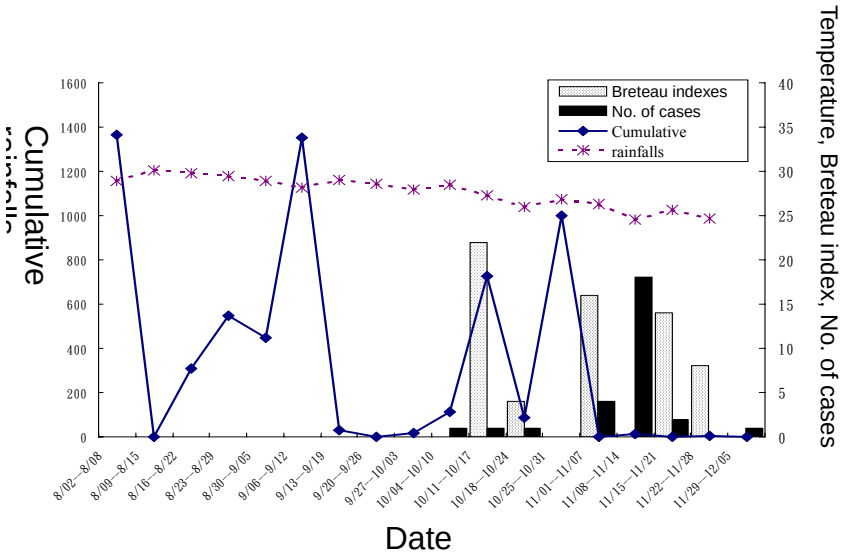
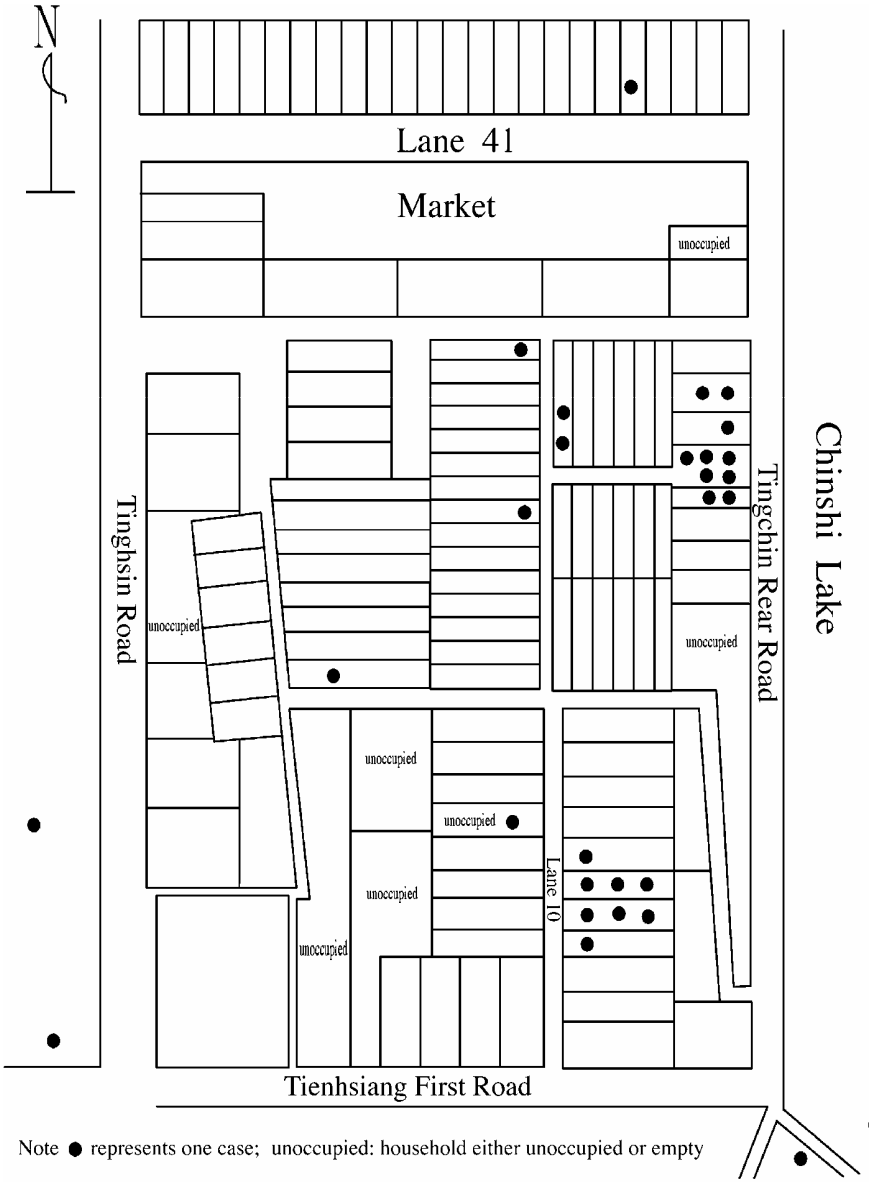


Figure3. Distribution of Cases



Note ● represents one case; unoccupied: household either unoccupied or empty