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Impact of 'carpet-combing' vector control operations in terminating the 2005 dengue outbreak in Singapore

Introduction

Dengue fever is endemic in Singapore. In the past two decades, a surge in cases was observed in 1992, 1998 and 2005. The worst outbreak of dengue since the 1980s occurred in 2005 when a total of 14,209 cases were reported. It peaked at 713 cases in the third week of September.

In response to the dengue threat, a two-pronged strategy comprising outdoor 'carpet-combing' and indoor '10-minutes mozzie wipe-out' was implemented. The 'carpet-combing' exercise is an intensive 'search-and-destroy' operation led by the National Environmental Agency (NEA). It was carried out during six weekends by thoroughly searching out and eliminating *Aedes* mosquito breeding sites in common outdoor areas of all public and private residential estates. More than 6,000 volunteers from various government agencies, town councils and grassroot organizations participated in this exercise which covered all the 84 electoral constituencies in six phases from 17 Sept to 22 October 2005. During this exercise, some 1000 mosquito breeding habits were found and destroyed, while another 8400 potential breeding sites were removed[1]. Fogging would only be carried out if field visits showed that there was an abundance of *Aedes* mosquitoes. The '10-minute mozzie wipe-out' initiative was a massive community outreach exercise to educate the public to check and remove stagnant water in homes. Some 10,000 volunteers spent their weekends distributing pamphlets to about 888,000 homes.

Materials and methods

We did a retrospective study on the weekly number of MD-131 notifications for dengue received in year 2005 stratified by the carpet-combing exercises, which were carried out in six mutually exclusive groups of pre-identified locations. The assumption for regression analysis of each carpet-combing exercise was that the impact of carpet-combing operation would be observed from two weeks after the exercise until the end of 2005. For example, the impact of the first exercise held on the last day of epidemiological (E)-week 37 was yielded in E-week 40 to E-week 52. The regression equation for each of the six carpet-combing exercises was:

$$Y_t = b_0 + b_1 t + b_2 X_t$$

where Y_t = weekly number of dengue notifications, t = 1, 2,…, 52

t = E-week number

X_t = dummy indicator for impact of carpet-combing operations

$$= \begin{cases} 0 \text{ when there was no impact} \\ 1 \text{ when there was impact from 'carpet-combing' operations} \end{cases}$$

As part of the intervention analysis, the dummy indicator was included in the regression model to represent the impact of 'carpet-combing' operations, which was coded as 0=had no impact, 1=had impact. Whether the carpet-combing operations had significant effect on the number of dengue notifications could be inferred from the significance of the regression coefficient for the dummy indicator. To compare the contributions of the predictors independent of the measurement units so as to assess which independent variables are most important, we used the standardized regression coefficients (betas)[2]. The beta weights in the multivariate regression models were used to estimate the unique predictive importance attributed to the natural progression of time series and impact of the carpet-combing operations. The ratio of the two beta weights was equivalent to the ratio of the estimated unique predictive importance of the two independent variables in each regression model.

Results

In the first half of 2005, a weekly average of 204 dengue cases was reported. The weekly number of cases surged to a peak at 713 cases in E-week 38 of 2005, which was double the peak at 332 cases in E-week 34 of 2004. *Fig. 1* shows the weekly dengue notifications in 2004 and 2005. The year 2005 began with a high incidence which was a continuation from the previous year, followed by a decline in late February. But the number of cases surged sharply and reached a second peak in September[3]. *Fig. 2* depicts the trend of weekly dengue notifications in the six 'carpet-combing' exercises, the round dots indicate the E-weeks in which the respective 'carpet-combing' operations were carried out. The standardized coefficients of E-week and 'carpet-combing' operations listed in *Table 1* indicate the strength of the effect attributed to the time component and intervention effect, respectively, from 'starting E-week of analysis' until E-week 52.

The standardized coefficient of the dummy indicator on the impact of 'carpet-combing' operation (beta2) was -0.47 for the first exercise. Controlling for the time component, the average number of dengue notifications decreased significantly by about half a standard deviation as a result of the intervention efforts due to the first 'carpet-combing' operation, which was greatest in magnitude compared to that of subsequent exercises.

Figure 1
Weekly dengue notifications in 2004 and 2005

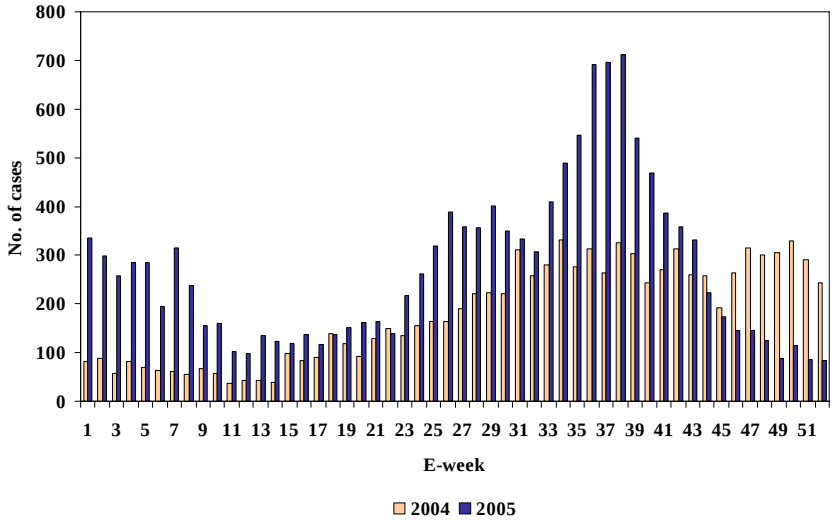


Table 1

Results of regression analyses of the six 'carpet-combing' exercises

nth Ex	Starting E-week of exercise[+]	Starting E-week of analysis[++]	E-week	Impact of carpet-combing operation		Ratio of magnitude of beta1 to beta2
			Standardized coefficient (beta1)*	Standardized coefficient (beta2)*	P-value	
1	E-Week 37	E-Week 36	-0.54	-0.47	<0.0005	1.15
2	E-Week 38	E-Week 38	-1.08	0.16**	0.12	6.75
3	E-Week 39	E-Week 38	-0.59	-0.32	0.19	1.84
4	E-Week 40	E-Week 38	-0.61	-0.38	0.04	1.61
5	E-Week 41	E-Week 37	-0.78	-0.21	0.51	3.71
6	E-Week 42	E-Week 37	-0.80	-0.13	0.56	6.15

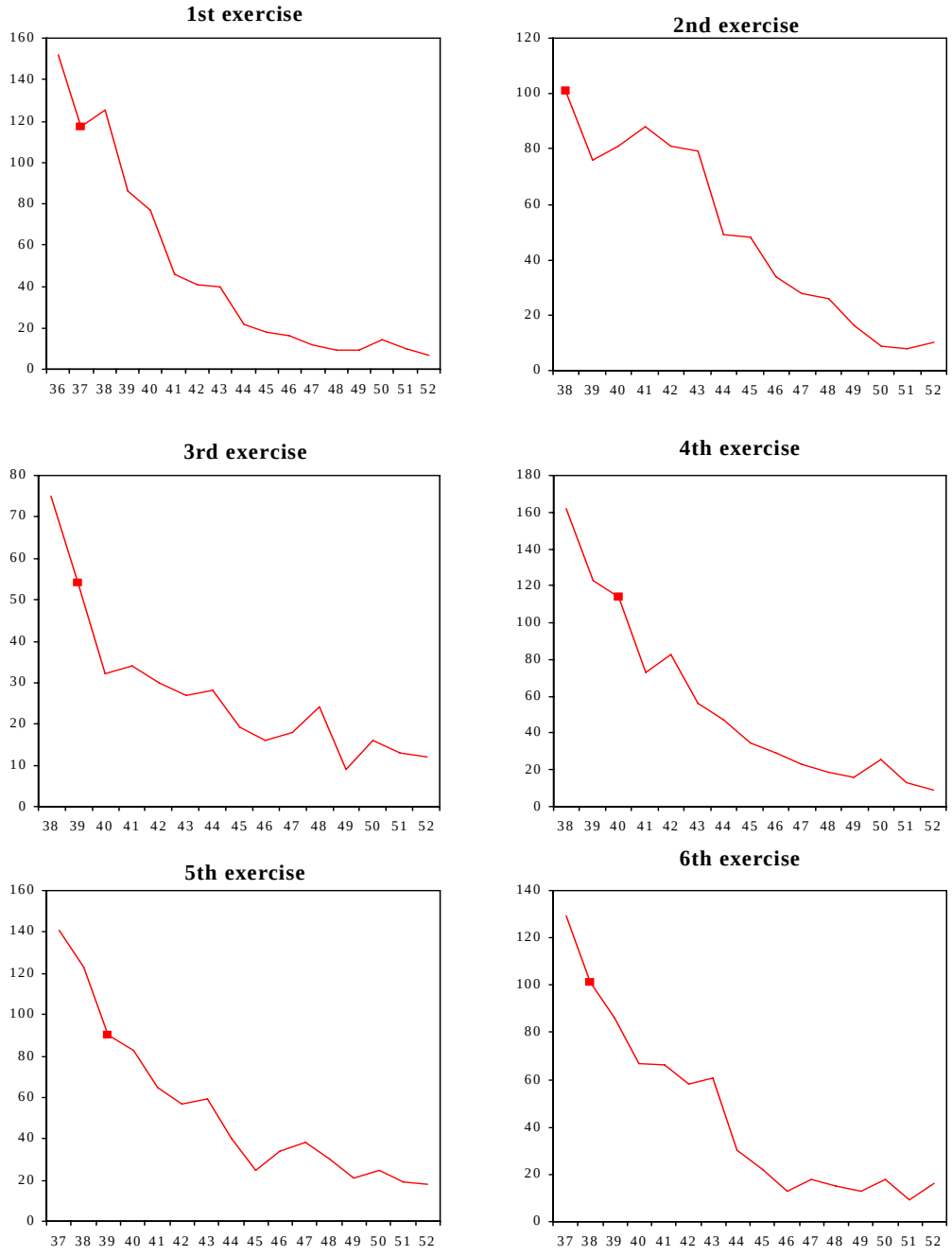
[+] Dates of the 'carpet-combing' exercises were: 1st exercise on 17/18 Sep, 2nd on 24/25 Sep, 3rd on 1 Oct, 4th on 8 Oct, 5th on 15 Oct, and 6th on 22 Oct 2005.

[++] The starting E-week of each regression analysis was selected based on the turning point (i.e. peak) of dengue notifications prior to the 'carpet-combing' exercise. The adjusted R-square of the six regression models ranged from 0.70 for exercise 3 to 0.93 for exercise 2.

* P-value all < 0.01.

** Note the difference in sign of beta2.

Figure 2
Trend of weekly dengue notifications in the six 'carpet-combing' exercises



We observed a consistent increase in magnitude of beta1 for subsequent exercises (except for the second exercise). There was a decreasing rate of 'returns' in terms of the reduction in dengue notifications from 'carpet-combing' operations, as the magnitude of beta2 further decreased in subsequent exercises. When the ratio of the magnitude of beta1 to beta2 was greater than one, the contribution of the time component was deemed to be greater than that of the 'carpet-combing' operations in the reduction of dengue notifications, which was observed for all the six exercises.

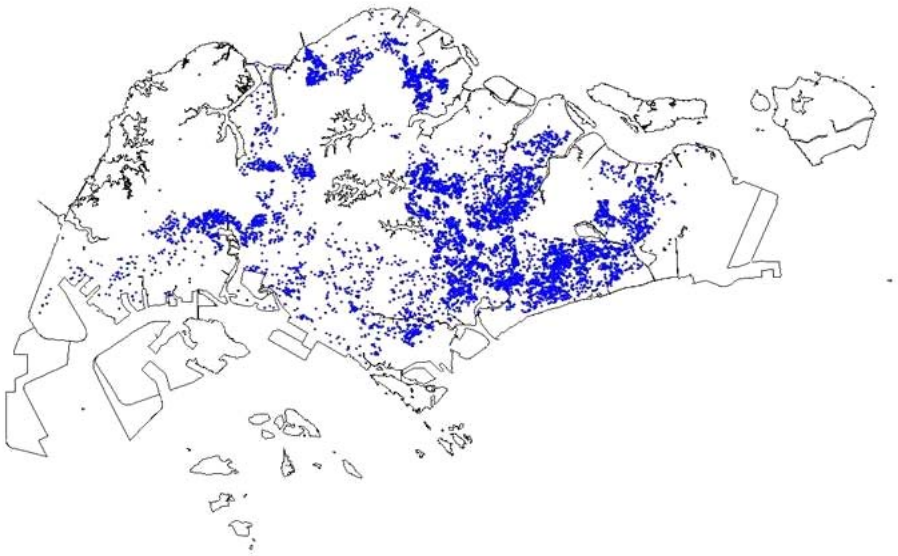
Geographically, dengue has established in previously classified low-endemic areas in the western part of Singapore since 2004[4]. *Fig. 3* shows the geographical distribution of dengue cases notified in 2005. As the impact of the 'carpet-combing' operations on the transmission dynamics could have differed and these exercises were not carried out concurrently, the caveat is that comparison may not be direct. The peak in the national number of dengue notifications was in E-week 38 and the sixth exercise was carried out about four weeks later when the national number of dengue notifications showed a rapid declining trend.

Comments

The first exercise provided the greatest impact in reducing the number of dengue notifications independent of the time component, compared to subsequent exercises. The reduction in dengue notifications attributable to the 'carpet-combing' operations was found to be greatest when it was carried out during the peak of dengue outbreak.

As case-based intervention does not indicate efficacy, innovative approaches are required in order for *Aedes aegypti* control strategies to be effective[5]. The findings from this study showed some promising

Figure 3
Geographical distribution of dengue notifications in 2005



results from the 'carpet-combing' operations. In addition to scheduling 'carpet-combing' operations at appropriate timing for maximum yield with close surveillance of dengue notifications, public education on dengue prevention and community participation in control activities remain key to the campaign against dengue in Singapore.

(Reported by Ang LW, Foong BH, Ye T, Chow A and Chew SK, Communicable Diseases Division, Ministry of Health)

Editorial comments

A mathematical model developed in collaboration between Ministry of Health, Singapore, and Sao Paulo University, Brazil, showed that the combined *Aedes* control strategy using adulticidal and larvicidal methods seems to be very effective in reducing the number of dengue cases in the first week after the start of the outdoor 'carpet-combing' and indoor '10-minute mozzie wipe-out' vector control measures[6].

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Seroprevalence study on past and recent dengue virus infection in Singapore

In Singapore, dengue seroprevalence in the general population was monitored periodically in 1982-1984[1], 1988, 1990-1991, 1993, and 1998[2]. Based on these studies, the seroprevalence of dengue in the general population was found to vary from 45.6% in 1982 - 1984 to 29.4% in 1998. Risk factors which have been shown to be significantly associated with seroprevalence include type of residential premises and floor level of high-rise residential apartments.

Another national serological survey was conducted in 2005 to determine the prevalence of past and recent dengue infection in the resident population, and

to identify the potential risk factors associated with the acquisition of dengue infection in Singapore.

Methods and materials

The survey was based on stored blood samples of the 2004 National Health Survey (NHS 2004) collected between September and December. In that survey, a total of 4,152 participants aged 18 – 74 years had consented to have their residual sera used for future research. These samples are representatives of the Singapore population aged 18 – 74 years and were selected by a combination of disproportionate stratified sampling and systematic sampling.

Sera from all NHS 04 subjects were stored in a freezer at the Department of Pathology, Singapore General Hospital. The stored sera of eligible subjects were sent to the Environmental Health Institute (EHI), National Environmental Agency, for analyses of IgG and IgM antibodies against dengue to determine past and recent exposure to the virus. Individuals found positive for IgM &/or IgG (PanBio Capture/ Indirect ELISA) were classified as 'those ever have been infected with dengue', while individuals found positive for IgM (PanBio Capture ELISA) and/or high-titre IgG (PanBio Capture IgG >22 PanBio units) were classified as those with 'recent dengue infection'.

The results were sent to the Communicable Diseases Division, Ministry of Health, for statistical analysis. Prior to data analysis, subjects' identifiers such as NRIC number were de-linked from the test results. Statistical analysis was performed using the statistical software package, Statistical Package for Social Sciences (SPSS) 14.0. The data was adjusted to the age, ethnic group and gender distribution of the 2004 Singapore resident population to ensure that the characteristics of the samples conformed to those of the general population.

Findings

Characteristics of individuals ever infected with dengue

Overall, 61.6% of the study population were positive for dengue antibody indicating that they had ever been infected with dengue.

Among the three major ethnic groups, Indians had a significantly higher seropositivity (72.3%) compared to that of Chinese (60.9%) and Malays (59.3%) ($p<0.0005$). The lowest age-specific seropositivity of 18.4% was found in the 18 – 24 year age group. Seropositivity was significantly higher in the older age groups and the highest prevalence of 91.8% was found in the 55 – 74 year age group. No significant difference in seropositivity between male and female participants was detected (*Table 2*).

The proportion of individuals ever been infected with dengue was much lower among the students (19.4%) and national service (NS) men (14.1%) compared to the remaining groups such as the employed (60.3%), the unemployed (72.9%), housewives (79.5%) and retirees (92.8%) (*Table 2*).

Seropositivity was significantly higher among residents of landed properties compared to occupants of HDB apartments (70.1% vs. 61.0%, $p<0.005$) and private condominiums (70.1% vs. 61.9%, $p=0.04$).

Risk factors associated with presence of dengue antibodies

Based on univariate analysis, ethnic Indians, older age groups and employment status in the past

Table 2

Univariate analysis of antibodies against dengue among the general population by selected characteristics

Characteristics	No. positive/ No. tested	(%)	Odds ratio	95% CI	P value
Gender					
Male	1295 / 2058	(62.9)	1.00	Referent	-
Female	1264 / 2094	(60.4)	0.90	(0.79, 1.02)	0.088
Ethnic Group ***					
Chinese	2006 / 3293	(60.9)	1.00	Referent	-
Malay	308 / 520	(59.3)	0.94	(0.78, 1.13)	0.508
Indian	245 / 339	(72.3)	1.68	(1.31, 2.15)	<0.0005
Age group (yrs)***					
18 – 24	94 / 512	(18.4)	1.00	Referent	-
25 – 34	330 / 899	(36.7)	2.57	(1.98, 3.34)	<0.0005
35 – 44	674 / 1046	(64.5)	8.07	(6.24, 10.44)	<0.0005
45 – 54	740 / 910	(81.3)	19.31	(14.61, 25.52)	<0.0005
55 – 74	721 / 785	(91.8)	50.13	(35.69, 70.41)	<0.0005
Main employment status over last 12 months ***					
Student	48 / 247	(19.4)	1.00	Referent	-
National serviceman	11 / 78	(14.1)	0.68	(0.33, 1.38)	0.283
Employed	1731 / 2873	(60.3)	6.22	(4.50, 8.59)	<0.0005
Unemployed	86 / 118	(72.9)	10.86	(6.51, 18.14)	<0.0005
Homemaker/Housewife	535 / 673	(79.5)	15.85	(11.00, 22.84)	<0.0005
Retired	142 / 153	(92.8)	55.55	(27.57, 111.93)	<0.0005
Type of residential premises *					
Landed property	185 / 264	(70.1)	1.00	Referent	-
HDB apartment	2189 / 3589	(61.0)	0.67	(0.51, 0.88)	0.004
Condominium/ private apartment	185 / 299	(61.9)	0.69	(0.49, 0.98)	0.041
Floor level **					
Landed property	185 / 264	(70.1)	1.47	(1.10, 1.96)	0.009
HDB, condominium and private apartment					
Ground	72 / 102	(70.6)	1.49	(0.96, 2.32)	0.075
2 - 9 floor	1575 / 2599	(60.6)	0.97	(0.84, 1.11)	0.627
10 or higher	725 / 1180	(61.4)	1.00	Referent	-

Significance of characteristics indicated by * p <0.05; ** p <0.01; *** p <0.001.

12 months (i.e. the employed, housewives, the unemployed and retirees) were identified as risk factors associated with exposure to dengue virus infection (*Table 2*). However, the association between occupational status and seropositivity might be confounded by age as majority of the participants in some of the groups were older than students and national servicemen. Residents of landed properties were found to have a higher risk of ever been infected with dengue than those staying in HDB estates and condominiums.

Characteristics of individuals with recent dengue infection

The proportion of study participants with recently acquired dengue infection was 2.6% (95% CI: 2.1% – 3.1%). There were no significant differences in the prevalence of recent dengue infection by gender and ethnic groups ($p>0.1$). The proportion of individuals with recent dengue infection was lowest in the 18 – 24 year age group (1.2%), and highest in the 45 – 54 year age group (3.2%). A significant increase in the prevalence of recent dengue infection was observed among the older age groups (*Table 3*).

Students and national servicemen had the lowest prevalence of recent infection (1.2% and 1.3%, respectively). Among the other groups, 3.3% of retirees had recent dengue infection followed by housewives (2.8%), the employed (2.7%) and the unemployed (2.6%).

The prevalence of recent exposure to dengue was lower among residents of landed properties (1.9%) compared to those of HDB housing estates (2.7%) and private apartments (2.7%). Among occupants of multi-storey apartments, the prevalence was highest for ground floor residents (3.9%) compared to residents living on second floor and above (2.5%).

Risk factors associated with recent dengue infection

Based on univariate analysis, age group and occupational status in the past 12 months were significantly associated with recent dengue infection. The risk for recent dengue infection increased significantly with age and the increase approximately doubled for every 10 years increase in age (*Table 3*).

Comments

Unlike previous seroprevalence surveys, the subjects of this survey were representatives of the general population in Singapore. The prevalence (61.6%) was slightly lower than the weighted prevalence for the corresponding age group reported in 1993[3] (71.4%) and 1998[4] (64.0%). [A total of 598 and 668 volunteers aged 18 – 74 years were enrolled in 1993 and 1998, respectively and the laboratory used the haemagglutination-inhibition (HI) method]. Although a significant decline in dengue seropositivity was observed between 1993 and 1998 ($p<0.01$), there was no significant change in seropositivity between 1998 and 2004 ($p>0.05$). Cautions should be made in comparing the seroprevalence data as the 1998 survey only measured the IgG (HI) antibody.

In this survey, 2.6% of the subjects had serological evidence of recent dengue infection. When the study population was projected to the 2005 resident population aged 15 years and above (2.78 million), it was estimated that about 72,000 could have been infected. However, only a total of 3736 infected resi-

Table 3
Univariate analysis of seroprevalence of recent dengue infection among the general population by selected characteristics

Characteristics	No. positive/ No. tested	(%)	Odds ratio	95% CI	P value
Gender					
Male	57 / 2058	(2.8)	1.00	Referent	-
Female	53 / 2094	(2.5)	0.86	(0.59, 1.27)	0.451
Ethnic Group					
Chinese	89 / 3293	(2.7)	1.00	Referent	-
Malay	11 / 520	(2.1)	0.78	(0.41, 1.47)	0.445
Indian	10 / 339	(2.9)	1.59	(0.80, 3.14)	0.183
Age group (yrs) * **					
18 - 24	6 / 512	(1.2)	1.00	Referent	-
25 - 34	23 / 899	(2.6)	2.59	(1.07, 6.28)	0.035
35 - 44	29 / 1046	(2.8)	5.02	(2.11, 11.93)	<0.0005
45 - 54	29 / 910	(3.2)	11.17	(4.67, 26.70)	<0.0005
55 - 74	23 / 785	(2.9)	23.02	(9.23, 57.40)	<0.0005
Main employment status over last 12 months * **					
Student	3 / 247	(1.2)	1.00	Referent	-
National serviceman	1 / 78	(1.3)	1.31	(0.14, 12.41)	0.816
Employed	79 / 2873	(2.7)	5.44	(1.54, 19.29)	0.009
Unemployed	3 / 118	(2.6)	8.53	(1.61, 45.07)	0.012
Homemaker/Housewife	19 / 673	(2.8)	11.08	(2.93, 41.99)	<0.0005
Retired	5 / 153	(3.3)	36.72	(7.10, 189.91)	<0.0005
Type of residential premise					
Landed property	5 / 264	(1.9)	1.00	Referent	-
HDB apartment	97 / 3589	(2.7)	0.99	(0.41, 2.42)	0.988
Condominium/private apartment	8 / 299	(2.7)	0.99	(0.32, 3.05)	0.983
Floor level					
Landed property	5 / 264	(1.9)	1.20	(0.46, 3.10)	0.707
HDB, condominium/private apartment					
Ground	4 / 102	(3.9)	2.07	(0.65, 6.61)	0.219
2 - 9 floor	75 / 2599	(2.8)	1.26	(0.79, 1.98)	0.331
10 or higher	26 / 1180	(2.2)	1.00	Referent	-

Significance of characteristics indicated by * p <0.05; ** p <0.01; *** p <0.001.

dents developed clinical symptoms and were notified to the Ministry of Health as dengue during the period from September to December 2004. The estimated ratio of symptomatic vs asymptomatic dengue was 1:19. This was similar to the estimation made in earlier surveys[2].

The risk factors found to be associated with acquisition of dengue infection in this survey were also similar to those reported in previous studies (e.g. residents of landed properties and ground floors of high-rise apartments).

(Reported by Tun Y, Ang LW, Chow A and Chew SK, Communicable Diseases Division, Ministry of Health)

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Sexually transmitted infections in Singapore, 2006

Disease trends

In 2006, the overall incidence for sexually transmitted infections (STIs) was 245 per 100,000 population. This rate had increased sharply from 195 per 100,000 population in 2003 to 252 per 100,000 population in 2004, and subsequently rose slightly to 254 per 100,000 population in 2005 (*Fig. 4*). The three main bacterial STIs notified were gonorrhoea, non-gonococcal urethritis (NGU) and syphilis.

Gonorrhoea was the most common STI. The incidence for NGU had declined compared to the previous year, while the third commonest STI, syphilis, had increased. The incidence of other STIs, comprising mainly genital discharge, genital herpes, genital warts, genital candidiasis, chancroid and trichomoniasis was 114 per 100,000 population. The incidence of genital herpes has risen steeply in recent years and reached 27 per 100,000 population in 2004, followed by a slight drop to 26 per 100,000 population in 2005 and 2006.

Distribution by age and gender

The male to female ratio was 2:1. As in previous years, the age-specific incidence rate for STIs among females was highest in the age group 20 - 24 years. Among the males, the highest age-specific incidence rate was in the age group 25 - 29 years. The overall rate was highest in the 20 - 24 year age group (*Fig. 5*).

Main types of STIs

Gonorrhoea

The incidence rate of gonorrhoea was 54 per 100,000 population in 2006, a decrease from 60 per

Figure 4
Incidence of STIs by specific type, 1980 - 2006

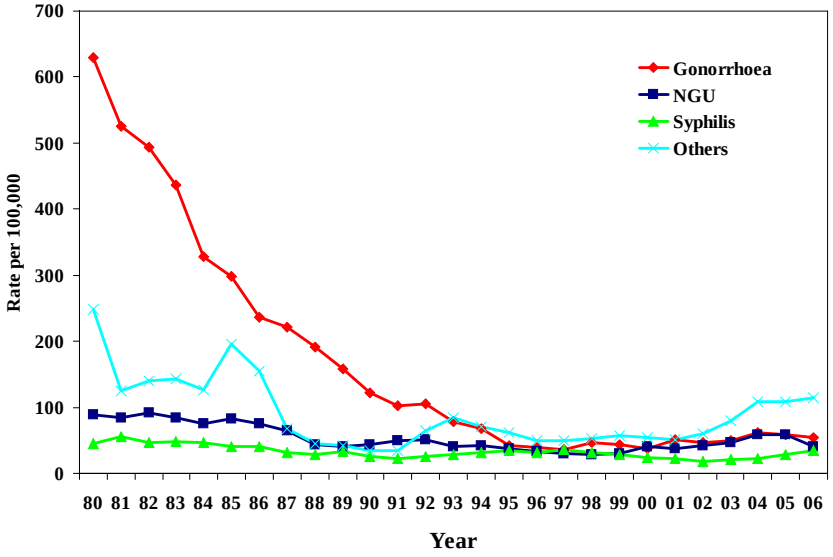
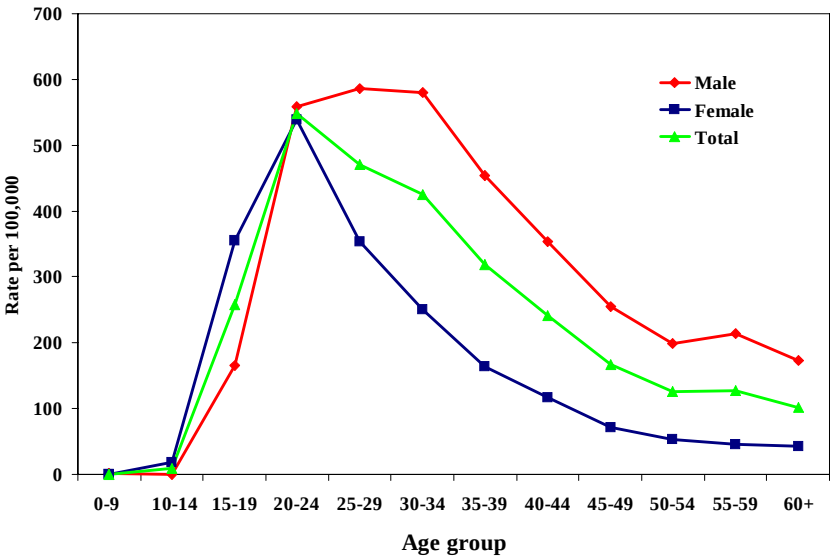


Figure 5
Age-specific incidence of STIs, 2006



100,000 population in 2005. There were no cases of gonococcal ophthalmia neonatorum in 2006. The prevalence of penicillinase-producing *Neisseria gonorrhoeae* (PPNG) was 48.5% in 2006, which was a slight decrease from 49.0% in 2005. The incidence of *Neisseria gonorrhoeae* resistant to Ciprofloxacin increased from 59.4% in 2005 to 61.9% in 2006.

Non-gonococcal urethritis (NGU)

The incidence rate of NGU was 41 per 100,000 population in 2006. This was a decrease of about 29% from 58 per 100,000 population in 2004 and 2005.

Syphilis

The incidence rate of syphilis was 35 per 100,000 population in 2006, which was a 25% increase from 28 per 100,000 population in 2005. This increase was mainly attributed to non-infectious syphilis, which increased from 23 per 100,000 population in 2005 to 31 per 100,000 population in 2006. From a historical perspective, the incidence rate of syphilis decreased from 45 per 100,000 population in 1980 to 23 per 100,000 population in 1991. From 1992, there was an increase in the incidence rate from 26 per 100,000 population to 36 per 100,000 population in 1997. Subsequently, it declined to 18 per 100,000 population in 2002 before increasing to its current rate of 35 per 100,000 population in 2006.

The rate of infectious syphilis declined progressively from 18 per 100,000 population in 1986 to 3 per 100,000 population in 1999. It then increased to 5 per 100,000 population in 2004 and remained at 4 per 100,000 population in 2005 and 2006. There were two cases of congenital syphilis reported in 2006.

(Source: Department of STI Control, National Skin Centre)

Prevalence of mental disorders in Singapore

The burden imposed on the world by mental disorders is great. According to estimates from World Health Organisation (WHO)'s World Health Report in 2001, about 450 million people worldwide suffer from mental disorders.[1] One person in four will develop one or more mental or behavioural disorders during their lifetime. Mental and neurological disorders have also been estimated to account for 12.3% of the total disability-adjusted life years lost due to diseases and injuries in the world. Projections estimate that by the year 2020, neuropsychiatric conditions will account for 15% of disease burden, with unipolar depression alone accounting for 5.7%.

In Singapore, WHO estimates that mental disorders contribute up to 17% of the combined burden of premature death and living with ill health. A survey in a community sample of 2139 Singaporean children aged 6 to 12 estimated the prevalence rates of emotional and behavioral problems to be 12.5%.[2] From the period of February 2003 to March 2004, the first National Mental Health Survey of Singaporeans was

conducted. The National Mental Health Survey (2004) reported a lifetime prevalence of depression in adults of 5.6% and a lifetime prevalence of anxiety disorders of 3.4% in Singapore.[3] Up to 15.7% had symptoms of minor psychiatric morbidity and only 49.1% of those with mental disorders had sought assistance from general practitioners, psychiatrists, spiritual healers or religious leaders. Women had a higher risk of depression than men, with Indian women having the highest risk at 9.8%, followed by Malay (6.0%) and Chinese women (5.9%). Amongst men, Indian men had the highest risk of depression (7.5%), followed by Chinese (5.2%) and Malay men (2.3%). The main risk factors were having three or more major medical problems, divorced, being unemployed and low income. These findings were found to be comparable to epidemiological surveys conducted in other countries.[4-6]

Some mental disorders have a higher prevalence rate in the elderly, such as Alzheimer's disease and dementia. Alzheimer's disease affects 8 – 15% of people over the age of 65 [7], while the prevalence of dementia nearly doubles with every 5 years of age after age 60.[8] In Singapore, the National Mental Health Survey (2004) of the elderly reported a prevalence of dementia of 5.2% in those aged 60 years and above.[3] More women were affected than men (7.8% vs 2.2%), with Malays having the highest risk of developing dementia (9.4%), followed by Indians (8.8%) and Chinese (4.2%). The prevalence for depression was 3.1%, with Indian women the most at risk (*Table 4).* The elderly with mental disorders also face greater obstacles in accessing mental health services compared to the young.

Outlook for the future

The burden of mental disorders is unlikely to diminish. Singapore's population structure is expected to age progressively in the next 10 to 15 years. The United Nations Development Programme (UNDP) estimates that the percentage of elderly in Singapore will rise from 8.2% to 13.3% of the whole population.[9] Mental well-being in the elderly will thus become important. With the rapid ageing of the population in Singapore, there is an urgent need for the establishment of comprehensive, accessible and affordable psychogeriatric services. Unrecognized or untreated mental disorders such as Alzheimer's disease, dementia and depression can be severely impairing, even fatal. Improved dissemination of information to patients and clinicians will lead to better detection of early-stage patients, when timely intervention can lead to better outcomes.

Table 4

Prevalence rates of depression in the elderly (aged 60 years and above), 2003

	Males	Females	Total
Chinese	2.1%	2.8%	2.5%
Malay	5.7%	5.5%	5.6%
Indian	3.6%	10.3%	6.1%
Total	2.7%	3.5%	3.1%

(Reported by Lim W Y and Tan J Y, Epidemiology and Disease Control Division, Ministry of Health)

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A review on hand, foot and mouth disease situation in Singapore

Hand, foot and mouth disease (HFMD) is a common childhood viral disease characterized by brief prodromal fever, followed by pharyngitis, mouth ulcers and rash on the hands and feet. Children may have reduced appetite due to painful oral ulcers erupting on the tongue, gums or buccal mucosa. A non-pruritic vesicular rash or red spots typically appears on the hands and feet, most commonly on the palms and soles. The common causative agents for HFMD are *coxsackievirus* type A (CA), *echovirus* (EC) and *enterovirus* 71 (EV71). HFMD can be transmitted from person to person through the faecal-oral or respiratory route.

HFMD was made a legally notifiable disease from 1 October 2000 onwards, which coincided with a large HFMD outbreak associated with human enterovirus 71 [1].

A review on the epidemiological features of the disease during the period 2002-2006 was carried out.

Materials and methods

All cases of HFMD notified to the Communicable Diseases Surveillance Branch at the Ministry of Health were included in the study. The epidemiological data extracted from the notification forms and analyzed included age, gender, ethnicity, and preschool centres/schools attended. The attack rates of institutional outbreaks were calculated based on the population of the students and staff provided by the affected centres and schools. For the calculation of age-specific and ethnic-specific incidence rates, the denominators were the estimated mid-year population of the corresponding years compiled by the Dept of Statistics. Throat, stool or rectal swabs and swabs from ve-

sicular fluid and oral ulcers collected from selected HFMD cases at the KK Women's and Children's Hospital (KKH) and pre-school centres were tested for enteroviruses.

Results

The monthly distribution of reported HFMD cases for the period 2002-2006 is shown in *Fig. 6*. While an unimodal peak was observed in May 2002, bimodal peaks were noted for the epidemic years 2005 and 2006, with the first peak shifting earlier to March. The second peak in 2005 occurred in October while the second peak in 2006 was observed earlier in August.

With more focus on public health measures to control the spread of HFMD among preschool and primary school children, the size of the HFMD epidemics had diminished, from 16228 cases in 2002 to 15256 cases in 2005 and 15282 cases in 2006.

During the epidemic years of 2002, 2005 and 2006, the annual incidence rate was between 350.6 and 389.7 per 100,000 population compared with 133.9 per 100,000 population in 2003 and 151.2 per 100,000 population for 2004.

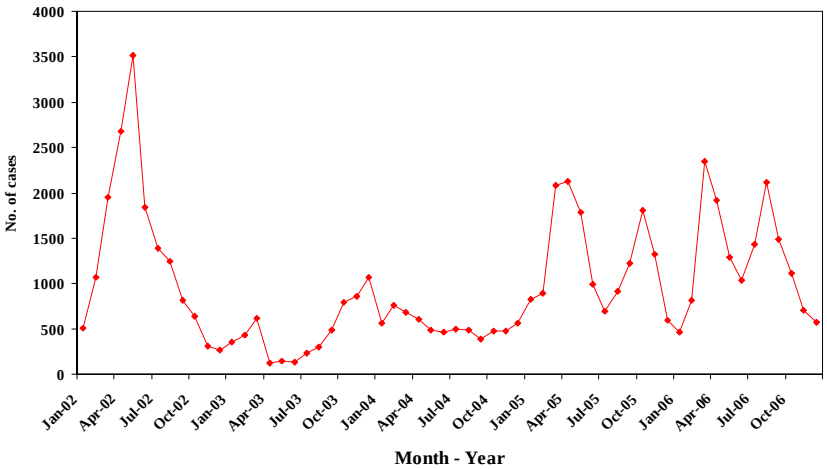
The incidence rate was highest in the 0 – 4 year age group, which ranged from 1882.0 per 100,000 population to 5465.5 per 100,000 population during the 5-year period (*Table 5*). This age group consti-

Table 5

Age-specific incidence (per 100,000 population) of HFMD cases, 2002-2006

Age group (years)	2002	2003	2004	2005	2006
0–4	5465.5	1882.0	2166.7	4888.6	4604.6
5–14	645.5	238.8	294.8	800.9	829.1
15–24	33.7	8.9	13.7	33.1	50.4
25–34	31.6	15.2	14.0	43.0	59.8
35–44	19.3	9.4	8.8	26.2	37.1
45–54	3.8	1.7	1.7	3.7	5.6
55+	0.9	0.3	0.9	1.0	1.8
Total	389.7	133.9	151.2	350.6	340.8

Figure 6
Monthly distribution of reported HFMD cases, 2002 - 2006



tuted 74.7% of the reported cases in 2002 and 63.1% in 2006 (*Fig. 7*). A gradual shift of the reported cases to the older age group of 5 – 14 years was also noted over the years. The proportion of cases in this age group increased from 21.2% in 2002 to 28.8% in 2006. There was a male predominance with a male to female ratio of 1.5:1 in 2002, 1.6:1 in 2003 and 1.3:1 in 2004 to 2006.

Among the three major ethnic groups, the incidence rate among the Chinese and Malays was higher than that of Indians (*Table 6*).

Institutional outbreaks of HFMD

The number of outbreaks, each with two or more cases, in childcare centres, kindergartens and schools

Figure 7
Age distribution (%) of HFMD cases, 2002-2006

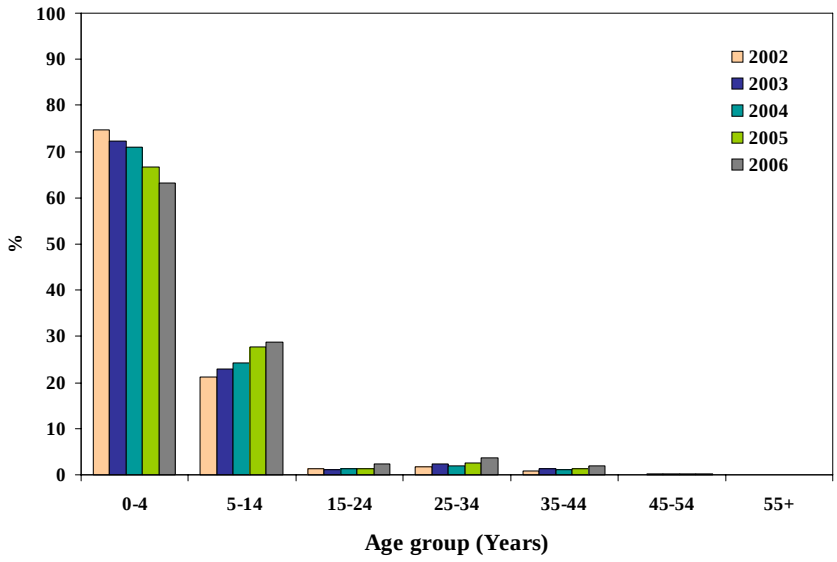


Table 6

Ethnic-specific incidence (per 100,000 population) of HFMD cases, 2002-2006

Ethnic group	2002	2003	2004	2005	2006
Singapore residents					
Chinese	488.4	165.1	187.8	444.3	407.6
Malay	487.5	136.2	188.8	382.6	491.7
Indian	155.1	43.0	50.8	114.8	151.4
Others	1153.8	709.2	524.1	689.4	605.8
Foreigners	36.7	12.4	5.7	75.7	92.4
Total	389.7	133.9	151.2	350.6	340.8

had been increasing since 2003 (*Fig. 8*). In 2006, there were 1363 reported outbreaks. This was 2.5 times higher than that in 2002.

Most of the outbreaks occurred in childcare centres (49.8% - 86.4% of the reported cases), followed by kindergartens (13.0% - 34.1%)[2,3,4,5]. While the number of institutional outbreaks had increased, a higher proportion of these outbreaks were observed to have lower attack rates of less than 10% (*Fig. 8*).

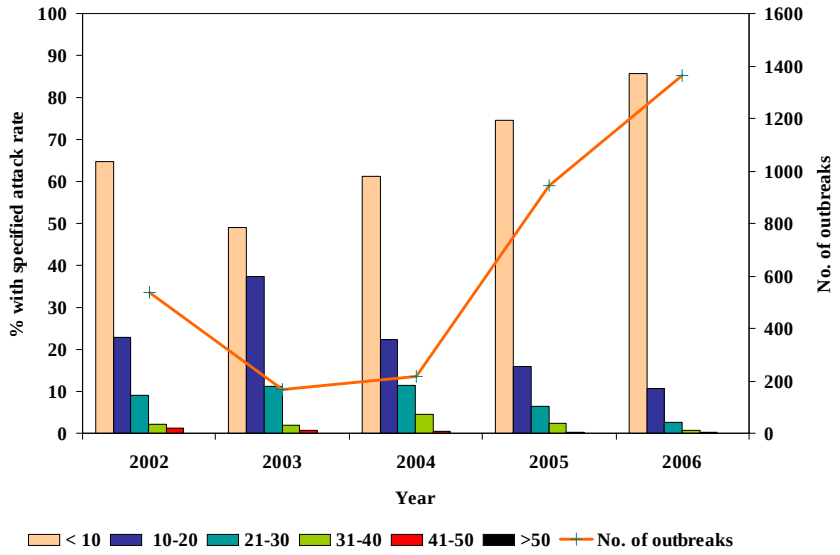
Majority of the enteroviruses detected from the cases were *coxsackievirus* type A (CA) in 2002 and 2004, while EV 71 was predominant in 2003. Both were almost equally distributed in 2005 and 2006. The predominant *coxsackievirus* serotype identified was CA16 in 2002, 2004 and 2005, CA 10 in 2003 and CA6 in 2006.

Comments

An epidemic of 3790 cases of HFMD caused by EV71 occurred in Sept-Nov 2000 [1]. Four children died. The epidemic was interrupted by swift coordinated interagency response that led to the closure of all preschool children from 1 Oct -15 Oct 2000. Another three EV 71-related deaths were reported in the non-epidemic year in 2001. Since then, there have not been any deaths from HFMD. However, a high degree of vigilance is maintained over the HFMD situation, in particular the circulation of EV 71.

HFMD is a common infection among preschool children. A serological survey carried out among 856 children below 12 years of age in Singapore over an 18-month period between July 1996 and December

Figure 8
Institutional outbreaks of HFMD by attack rate (%), 2002-2006



1997 at the National University Hospital showed that EV71 is acquired largely in the preschool years[6].

Public health measures continue to target at childcare centres, kindergartens and schools where susceptible children congregate. Cases in these institutions are being reported early and appropriate steps taken to interrupt transmission of infection. The effectiveness of these measures is evident from the lower attack rates of these outbreaks.

(Reported by Ang LW, Communicable Diseases Division, Ministry of Health)

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