

Air-/Droplet-Borne  
Diseases

Vector-Borne/  
Zoonotic Diseases

Food-/Water-  
Borne Diseases

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Diseases

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HIV/AIDS, STIs,  
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Childhood  
Immunisation

- Chikungunya Fever
- Dengue Fever/Dengue Haemorrhagic Fever (DF/DHF)
- Malaria

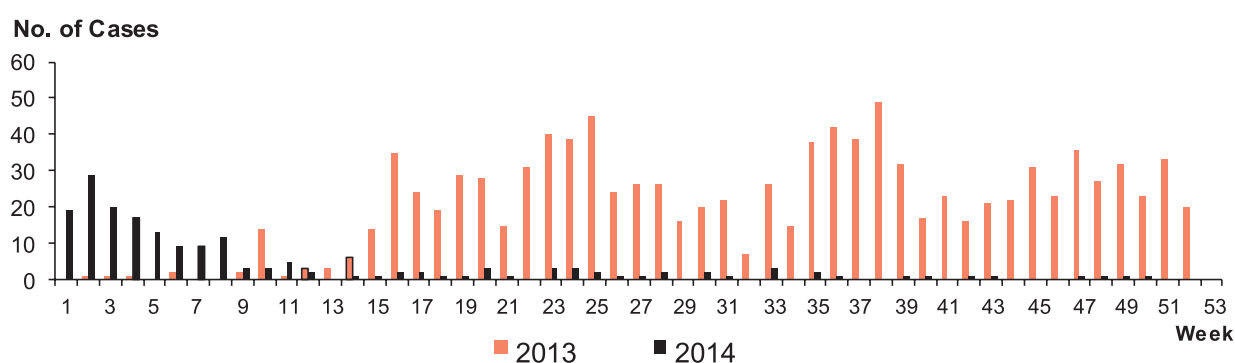
## II VECTOR-BORNE DISEASES

### CHIKUNGUNYA FEVER

Chikungunya fever is an acute febrile disease caused by the chikungunya virus. The disease is characterised by fever, joint pain with or without swelling, headache, fatigue, nausea and vomiting. Some patients may develop a rash affecting the trunk and limbs. The disease is usually self-limiting. Most symptoms last for 3 -10 days although the joint pain may last for weeks to months. The main vector in Singapore is the *Aedes albopictus* mosquito.

A total of 182 laboratory-confirmed cases of chikungunya fever were reported in 2014, compared to 1,059 laboratory-confirmed cases in 2013 (Figure 2.1). Out of the 182 cases, 43 were imported cases, involving 6 Singapore residents, 9 foreigners including work permit holders and 28 tourists or foreigners seeking medical treatment. The remaining 139 cases were indigenous cases. No deaths due to chikungunya were reported in 2014.

**Figure 2.1**  
E-weekly distribution of Chikungunya fever cases, 2013 – 2014



The incidence rate among indigenous cases was highest in the 35 – 44 years age group with a male to female ratio of 1.8:1 (Table 2.1). Among the three

major ethnic groups, Chinese and Indians had the highest incidence followed by Malays. Foreigners comprised 60.4% of the indigenous cases (Table 2.2).

**Table 2.1**  
Age-gender distribution and age-specific incidence rate of indigenous chikungunya fever cases<sup>^</sup>, 2014

Age	Male	Female	Total (%)	Incidence rate per 100,000 population*
0 – 4	0	1	1 (0.7)	0.4
5 – 14	5	0	5 (3.6)	1
15 – 24	13	4	17 (12.2)	2.2
25 – 34	24	15	39 (28.1)	3.1
35 – 44	22	11	33 (23.7)	3.4
45 – 54	10	8	18 (13.0)	2.4
55 – 64	9	8	17 (12.2)	3.0
65+	7	2	9 (6.5)	1.9
<b>Total</b>	<b>90</b>	<b>49</b>	<b>139 (100.0)</b>	<b>2.5</b>

<sup>^</sup>Cases acquired locally among Singaporeans, permanent and temporary residents.

\*Rates are based on 2014 estimated mid-year population.

(Source: Singapore Department of Statistics)

**Table 2.2**  
Ethnic-gender distribution and ethnic-specific incidence rate of indigenous chikungunya fever cases<sup>^</sup>, 2014

	Male	Female	Total (%)	Incidence rate per 100,000 population*
Singapore Resident				
Chinese	25	15	40 (28.8)	1.4
Malay	2	1	3 (2.2)	0.6
Indian	5	0	5 (3.6)	1.4
Others	4	3	7 (5.0)	5.5
Foreigner	54	30	84 (60.4)	5.4
<b>Total</b>	<b>90</b>	<b>49</b>	<b>139 (100.0)</b>	<b>2.5</b>

<sup>^</sup>Cases acquired locally among Singaporeans, permanent and temporary residents.

\*Rates are based on 2014 estimated mid-year population.

(Source: Singapore Department of Statistics)

There were 43 (23.6%) imported cases, defined as residents and non-residents with a history of travel to chikungunya-endemic countries within twelve days prior to the onset of illness. 33 (76.7%) and 4 (9.3%) had travelled to Indonesia and Philippines respectively (Table 2.3).

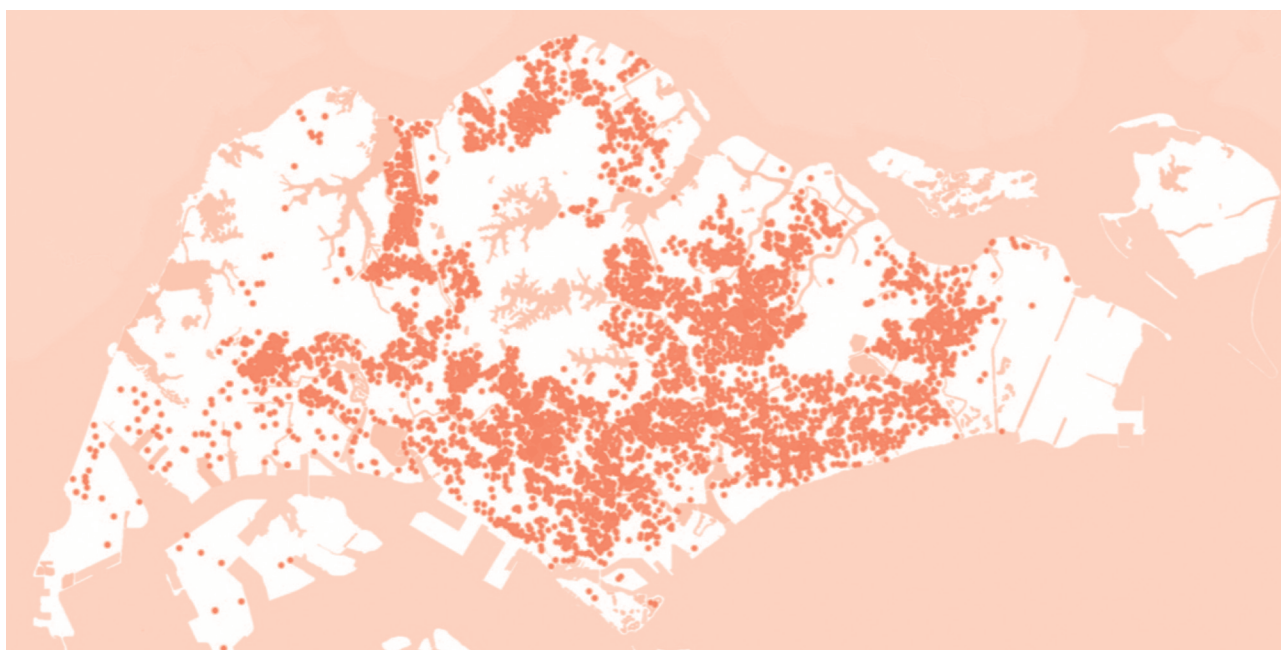
**Table 2.3**  
Imported chikungunya fever cases, 2010 – 2014

	Year				
	2010	2011	2012	2013	2014
<b>Southeast Asia</b>					
Thailand	0	0	0	2	1
Myanmar	0	0	0	0	0
Malaysia	2	4	0	5	1
Indonesia	6	1	5	15	33
Philippines	1	0	2	7	4
<b>South Asia</b>					
Bangladesh	0	0	0	1	
India	11	3	12	18	1
Maldives	0	0	0	0	
Other Regions	0	1	0	0	3
<b>Total</b>	<b>20</b>	<b>9</b>	<b>19</b>	<b>48</b>	<b>43</b>

The geographical distribution of indigenous chikungunya fever cases and *Aedes albopictus* is as follows (Figure 2.2).

**Figure 2.2**

**Geographical distribution of indigenous chikungunya fever cases and *Aedes albopictus*, 2014**



(Source: National Environment Agency)

**Table 2.4**

**Total number of notifications received for chikungunya disease, 2010-2014\***

Age	2010		2011		2012		2013		2014	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0 – 4	0	0	0	0	0	0	4	0	1	0
5 – 14	0	1	1	0	0	0	30	2	5	0
15 – 24	1	1	0	0	2	0	82	2	17	0
25 – 34	4	6	1	4	0	4	294	8	39	3
35 – 44	0	2	0	4	1	8	294	17	33	4
45 – 54	1	3	0	0	0	2	141	4	18	5
55 - 64	0	2	0	0	0	0	101	4	17	1
65+	0	1	0	0	0	0	65	2	9	2
<b>Total</b>	<b>6</b>	<b>16</b>	<b>2</b>	<b>8</b>	<b>3</b>	<b>14</b>	<b>1011</b>	<b>39</b>	<b>139</b>	<b>15</b>

\*excludes tourists and foreigners seeking medical treatment in Singapore

## DENGUE FEVER/DENGUE HAEMORRHAGIC FEVER (DF/DHF)

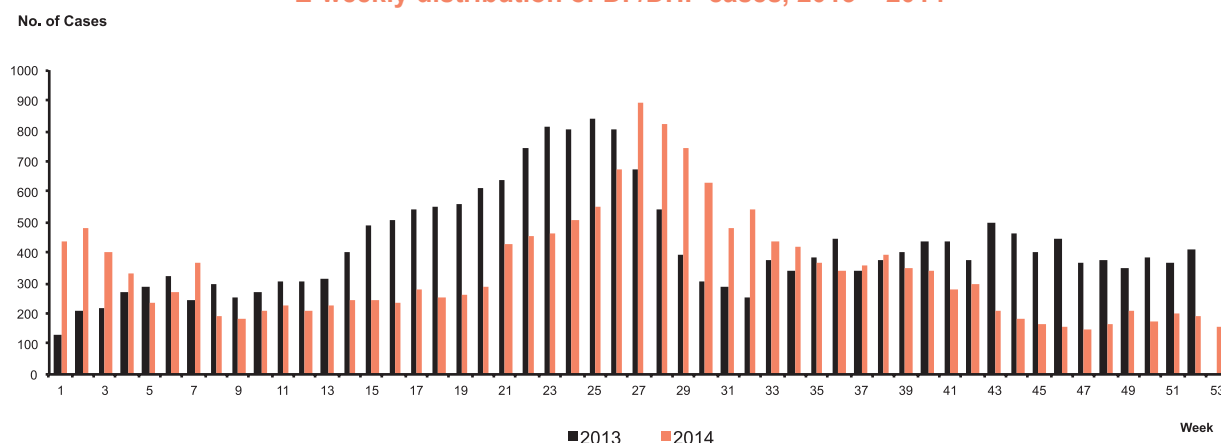
Dengue fever is an acute febrile viral disease characterised by sudden onset of fever for 3 – 5 days, intense headache, myalgia, arthralgia, retro-orbital pain, anorexia, gastrointestinal disturbances and rash. Early generalised erythema may occur in some cases. The infectious agents are flaviviruses comprising four serotypes (dengue-1, 2, 3 and 4) and are transmitted by the Aedes mosquito. In some cases, dengue haemorrhagic fever - a potentially fatal complication characterised by high fever, thrombocytopenia, haemorrhagic manifestations, and evidence of plasma leakage may develop.

A total of 18,326 laboratory confirmed cases of DF/DHF [comprising 18,306 cases of dengue fever (DF) and 20 cases of dengue haemorrhagic fever (DHF)] were

reported in 2014, a decrease of about 17 percent from the 22,170 dengue fever cases reported in 2013. Out of the 18,326 cases, 514 cases were imported cases involving 213 Singapore residents and 301 foreigners including work permit holders. The remaining 17,812 cases were classified as indigenous cases.

With continuation from 2013 epidemic, the incidence in the beginning of 2014 until the E-Week 7 was found high. Then the incidence declined starting from E-week 8 and remained plateau until E-week 17. Then it increased again in E-week 18 reaching a peak in E-week 28 and decreased from E-weeks 28 to 37, after-which the incidence fluctuated with downward trends for the rest of the year (Figure 2.3).

**Figure 2.3**  
E-weekly distribution of DF/DHF cases, 2013 – 2014



The incidence rate among indigenous cases was highest in the age group of 15-24 with a male to female ratio of 1.9 :1 (Table 2.5). Among the three major

ethnic groups, Chinese had the highest incidence rate, followed by Malays and Indians. Foreigners comprised 40.8% of the indigenous cases (Table 2.6).

**Table 2.5**  
Age-gender distribution and age-specific incidence rates of indigenous<sup>^</sup> DF/DHF cases, 2014

Age (Yrs)	Male	Female	Total	(%)	Incidence rate per 100,000 population*
0 – 4	109	72	181	1.0	80.5
5 – 14	679	486	1165	6.5	244.2
15 – 24	2,148	1,021	3169	17.8	415.3
25 – 34	3,600	1,371	4971	27.9	399.9
35 – 44	2,524	1,265	3789	21.3	389.2
45 – 54	1,502	882	2384	13.4	321.3
55 - 64	675	581	1256	7.1	220.3
65+	457	440	897	5.0	188.4
<b>Total</b>	<b>11,694</b>	<b>6,118</b>	<b>17,812</b>	<b>100.0</b>	<b>325.6</b>

<sup>^</sup>Cases acquired locally among Singaporeans, permanent and temporary residents.

\*Rates are based on 2014 estimated mid-year population.

(Source: Singapore Department of Statistics)

**Table 2.6**  
Ethnic-gender distribution and ethnic-specific incidence rates of indigenous<sup>^</sup>  
DF/DHF cases, 2014

	Male	Female	Total	(%)	Incidence rate per 100,000 population*
Singapore Resident					
Chinese	4,491	3,565	8,056	45.2	280.3
Malay	762	520	1,282	7.2	248.1
Indian	303	195	498	2.8	141.1
Others	458	244	702	4.0	554.1
Foreigner	5,680	1,594	7,274	40.8	454.9
<b>Total</b>	<b>11,694</b>	<b>6,118</b>	<b>17,812</b>	<b>100.0</b>	<b>325.6</b>

<sup>^</sup>Cases acquired locally among Singaporeans, permanent and temporary residents.

\*Rates are based on 2014 estimated mid-year population.

(Source: Singapore Department of Statistics)

**Table 2.7**  
Total number of notifications received for DF/DHF Cases<sup>^</sup> 2010 - 2014

Age	2010		2011		2012		2013		2014	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0 – 4	64	1	70	-	72	2	157	2	181	4
5 – 14	322	8	325	5	315	5	1,257	9	1,165	18
15 – 24	835	27	839	16	864	27	4,118	18	3,169	46
25 – 34	1,175	64	1,153	27	1,252	47	5,907	32	4,971	106
35 – 44	1,186	59	1,019	22	1,049	26	4,552	41	3,789	83
45 – 54	663	21	739	13	643	19	2,889	18	2,384	46
55 - 64	376	13	479	7	463	3	1,660	16	1,256	23
65+	357	5	475	1	434	4	1,323	7	897	13
<b>Total</b>	<b>4,978</b>	<b>198</b>	<b>5,099</b>	<b>91</b>	<b>5,092</b>	<b>133</b>	<b>21,863</b>	<b>143</b>	<b>17,812</b>	<b>339</b>

<sup>^</sup>excludes tourists and foreigners seeking treatment in Singapore

There were 514 (2.9%) imported cases, defined as Singaporeans, permanent and temporary residents with a history of travel to dengue endemic countries within seven days prior to the onset of illness. The majority of these cases (82.7%) were from Southeast

Asian countries: 214 from Malaysia, 143 from Indonesia, 27 from Thailand, 17 from Philippines, 8 each from Myanmar and Vietnam, 5 from East Timor, 1 each from Brunei, Cambodia and Laos and the rest are from other regions (Table 2.8).

**Table 2.8**  
Imported DF/DHF cases, 2010 – 2014

	Year				
	2010	2011	2012	2013	2014
<b>Southeast Asia</b>					
Brunei	1	1	0	1	1
Cambodia	1	8	11	2	1
East Timor	1	2	4	1	5
Indonesia	202	110	111	116	143
Laos	1	0	0	0	1
Malaysia	62	21	39	90	214
Myanmar	1	3	1	9	8
Philippines	16	12	13	10	17
Thailand	20	15	22	21	27
Viet Nam	12	9	4	6	8
<b>South Asia</b>					
Bangladesh	3	13	5	4	6
China	5	1	3	12	9
India	42	16	32	17	39
Maldives	0	1	2	1	6
Nepal	0	0	0	0	1
Pakistan	0	2	0	1	0
Sri Lanka	3	5	4	1	6
Other Regions	15	12	12	15	22
<b>Total</b>	<b>385</b>	<b>231</b>	<b>263</b>	<b>307</b>	<b>514</b>

Residents in Housing & Development Board (HDB) flats, Landed Properties (including shophouses) and Condominiums constituted 67.5%, 21.5% and 10.8% of the cases respectively. Compared to previous year,

the incidence rate of residents of landed properties houses (896.3 per 100,000) was about four times of residents in HDB flats (225.6 per 100,000). (Table 2.9).

**Table 2.9**  
Incidence rates of reported indigenous DF/DHF cases by housing type for Singapore residents, 2014

Housing Type	No.	%	Incidence rate per 100,000 population*
HDB Flats	7,117	67.5	225.6
Landed Properties (including shophouses)	2,266	21.5	896.3
Condominiums and Other Apartments	1,139	10.8	267.4
Others	16	0.2	43.0
<b>Total</b>	<b>10,538</b>	<b>100.0</b>	<b>272.2</b>

\*Rates are based on census of population 2014.  
(Source: Singapore Department of Statistics)

A total of 1,418 clusters involving 9,474 epidemiologically linked cases were identified in 2014, of which 137 clusters (9.7%) had 10 or more cases. Areas with more than 50 cases are listed in

Table 2.11. The median number of cases in these 137 clusters was 18 (range 10 to 534) and the median duration of transmission was 34 days (range 13 to 113) (Table 2.10).

**Table 2.10**  
Dengue clusters identified, 1990 – 2014

Year	No. of indigenous cases	No. of clusters*	No. of cases in cluster area (% total cases)	No. of clusters with $\geq 10$ cases (% total clusters)	Median no. of cases per cluster	Median duration of transmission (days)
1990	1,640	40	270 (16.5)	11 (27.5)	4.5	10
1991	2,062	74	414 (20.1)	9 (12.2)	3.5	6
1992	2,741	134	733 (26.7)	13 ( 9.7)	3	5
1993	794	33	183 (23.0)	4 (12.1)	3	8
1994	1,084	75	424 (39.1)	8 (10.7)	3	7
1995	1,756	118	679 (38.7)	16 (13.6)	3	7
1996	2,877	143	1,088 (37.8)	27 (18.9)	3	6
1997	4,039	198	1,124 (27.8)	24 (12.1)	3	5
1998	5,105	239	1,197 (23.4)	23 ( 9.6)	2	7
1999	1,138	54	230 (20.2)	6 (11.1)	3	11
2000	402	9	40 (10.0)	1 (11.1)	4	15
2001	2,064	93	531 (25.7)	15 (16.1)	3	8
2002	3,560	73	725 (20.4)	30 (41.1)	7	20
2003	4,542	180	1,405 (30.9)	38 (21.1)	4.5	12
2004	9,297	559	2,434 (26.2)	34 (6.1)	3	4
2005	14,032	1,190	5,362 (37.7)	93 (7.8)	3	5
2006	2,844	172	871 (30.6)	19 (11.0)	3	5
2007	8,287	949	3,877 (46.8)	58 (6.1)	3	10
2008	6,631	576	2,267 (34.2)	34 (5.9)	2	7
2009	4,187	392	1,456 (34.8)	17 (4.3)	3	7
2010	4,978	406	1,858 (37.3)	29 (7.1)	3	7
2011	5,099	433	1,904 (37.3)	32 (7.4)	3	7
2012	4,369	328	1,403 (30.9)	21 (6.4)	3	6
2013	21,863	1,475	10,256 (46.3)	188 (12.8)	3	9
2014	17,812	1,418	9,474 (51.7)	137 (9.7)	3	9

\*A cluster is defined as two or more cases epidemiologically linked by place [within 150m (200m till 2002)] and time (within 14 days)



**Table 2.11**  
**Dengue clusters identified, 2014 (50 or more cases)**

S/ No.	LOCALITY	No. of cases	Month
1	Choa Chu Kang Ave 2 (Blk 296,296A, 296B, 296C, 296D, 296E, 297, 297B, 297C, 297D) / Choa Chu Kang Ave 3 / Choa Chu Kang Ave 5 (Blk 476A, 476B, 476C, 476D,483,484,484A,484B,484D,485,485A,485B,485C,485D,486)/CS@Choa Chu Kang Ave 5/CS @ Keat Hong Cl	534	Jun - Aug
2	CS@Circuit Lk/Circuit Rd (Blk 37,38,39,40,41,42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 54, 55, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72,79, 85, 87) / Paya Lebar Way (Blk 91, 93, 120, 124) / Pipit Rd (Blk 53, 54, 55, 56,90,92,92A94)	236	Jun - Sep
3	Choa Chu Kang Ave 2(Blk 271,272, 273, 274, 276,287,294,295) / Choa Chu Kang Ave 3 (Blk 280, 284,285,289,290,291,293,401,402,403,404,405,406,408,409,411,412,469,470,472,473,474)Choa Chu Kang Ave 4 Blk422,427, 430,431,446,448,449,452,454,458,460,465,484.)	226	Jul - Aug
4	Belmont Rd / Cornwall Gdns / Farrer Rd / Holland Rd / CS @ Leedon Hts	187	Apr - Jun
5	Da Silva Ln / Florence Cl, Rd / Glasgow Rd / Kang Choo Bin Rd / Kovan Rd / CS @ Kovan Rise / Lim Ah Pin Rd / Lowland Rd / Phillips Ave / Richards Ave, Pl / Simon Ln / CS @ Simon Ln / Simon Pl, Rd, Walk / Teow Hock Ave / Upp S'goon Rd	172	May - Jul
6	Flora Dr (near TPE) / CS @ Flora Dr / Flora Rd / Jln Chelagi	172	May - Jul
7	Compassvale Dr(Blk 201B,202A,204A,204B,204D,212C,227B)/CS@Compassvale Rd/CS@Sengkang Sq/ Compassvale Rd(Blk 203A,203B,203C)/Compassvale Walk (Blk 223A,223B,223C,223D,224A,224B,224C,225A,225C,225B,226A,226B,226C,228C,231,232, 234,236,237,239,240,241)	171	Feb - May
8	Aroozoo Ave Ln/Charlton Rd/Hougang Ave 1(126)/Hougang St 11/Hougang St 11(Blk 52,154, 155, 156, 157,158, 159, 160,161),Jln Geneng / Kampong Sireh / Lor Ah Soo (Blk 138, 139, 140,141, 142, 143, 145) / Sireh Pl / Surin Ave, Ln / Taman Sireh / Upp S'goon Rd	169	Mar - Jul
9	CS @ Chestnut Ave / Chestnut Ave / Petir Rd (Blk 201, 202, 203, 204, 206, 207, 208, 209, 210, 211, 213, 214, 217, 218) / Petir Rd	135	Aug - Oct
10	Bedok Nth Rd (Blk 74, 76, 77, 80, 81, 82, 180, 183) / Jln Tanah Rata / Jln Tanjong / New Upp Changi Rd / CS @ Tanah Merah Kechil Lk / Tanah Merah Kechil Ave, Rd, Ridge, Rise / Upp Changi Rd	130	Aug - Oct
11	Jln Chermat / Lor Lew Lian / Lor Lew Lian (Blk 1, 2, 3, 4, 5, 6, 7) / Lor Ong Lye / S'goon Ave 1 (Blk 425, 426) / S'goon Central (Blk 409, 412, 413, 414, 415, 416, 417, 418, 419, 421, 422, 423) / Upp Paya Lebar Rd / Upp S'goon Rd	127	Mar - Jun
12	Hougang Ave 1 (Blk 101, 103) / Hougang Ave 3 (Blk 247, 248, 249, 251, 252, 253, 254) / Hougang St 22 (Blk 239, 240, 241, 242, 243, 244, 245, 246) / Jln Hock Chye / Jln Teliti / Tampines Rd / Tampines Rd (Blk 159)	124	May - Jul
13	Aroozoo Ave / Hougang Ave 1 (Blk 102, 103, 104, 106, 108, 109, 110, 111, 112, 114, 115, 116, 119, 236, 238) / Hougang Ave 3 (Blk 248) / Hougang St 21 (Blk 235, 237) / Hougang St 22 (Blk 239, 240, 242, 245) / Jln Lepas / Jln Pelikat / Jln Samarinda	112	Mar - Apr
14	Harvey Rd / Jln Gembira / Jln Hiboran / Jln Kemajuan / Jln Mesin / Jln Muhibbah / Jln Mulia / Jln Setia / Joo Seng Rd (Blk 11, 19, 20, 21) / Kampong Ampat / Macpherson Rd / Mactaggart Rd / Upp Aljunied Rd / Upp Aljunied Ln (Blk 2, 5)	86	Jun - Jul
15	Jln Loyang Besar / Loyang Besar Cl / Loyang Pl / CS @ Pasir Ris Link / CS @ Pasir Ris Rise / Pasir Ris Dr 4 (Blk 231, 232, 233, 240, 479, 480, 481, 483, 484, 486) / Pasir Ris Dr 6 (Blk 406, 468, 474, 475, 476) / Pasir Ris St 21 (Blk 238)	86	Jun - Jul
16	Court Rd / Cowdray Ave / Hemsley Ave / Huddington Ave / Hythe Rd / Jln Chulek / Kensington Pk Dr, Rd / Maju Ave / S'goon Nth Ave 1 (Blk 101, 104, 108, 111, 113, 114, 116, 120, 123, 125, 126, 142, 146, 147, 153) / Walmer Dr / Worthing Rd	81	Jun - Aug
17	Jln Grisek / Jln Krian / Jln Lapang / Jln Paras / Jln Sayang / Jln Selamat / Jln Senang / Jln Sentosa / Jln Senyum / Jln Waringin / Taman Kembangan / Waringin Pk	79	May - Jul
18	Happy Ave Central, East, Nth / Jln Anggerek / Jln Belangkas / Jln Chengkek / Jln Jermin / Jln Mawar / Jln Melati / Jln Melor / Macpherson Ln (Blk 82) / CS @ Macpherson Rd / Macpherson Rd	65	May - Aug
19	Hougang Ave 3 / Hougang Ave 3 (Blk 1, 2, 15, 17, 18, 20, 21, 22, 23) / Hougang St 31 (Blk 370, 371, 372, 373, 374, 375) / Jln Rengkam / Valley Rd / Tampines Rd / Upp S'goon Rd	60	May - Aug
20	Boscombe Rd / CS @ Boscombe Rd / Branksome Rd / Cres Rd / Goodman Rd / Parkstone Rd / Poole Rd / Swanage Rd / Tanjong Katong Rd / Wareham Rd	59	Jun - Aug
21	Ah Soo Gdn / Jln Kelichap / Jln Lokam / Paya Lebar Cres, Pl / Paya Lebar Walk / Tai Keng Gdns / Upp Paya Lebar Rd	58	Jun - Aug
22	Jln Korban / Jln Mahir / Jln Lokam / Jln Usaha / Rochdale Rd / Tai Keng Ave, Gdns, Ln, Pl / Thrift Dr / Upp Paya Lebar Rd	55	May - Jul
23	Jln Bunga Rampai / Joo Seng Rd / Joo Seng Rd (Blk 12, 14, 15, 16, 17, 18) / Shaw Rd / Vernon Pk	54	Jun - Aug
24	Rosewood Dr / CS @ Rosewood Dr	50	Jan - Feb
25	College Ave West / CS @ College Ave West	50	Aug - Aug

## Dengue Deaths

A total of six fatal cases were reported in 2014. Of these, five fatal cases were classified as indigenous infections among local residents. The remaining fatal

case was a non-resident foreigner seeking treatment in Singapore who had acquired the infection overseas.

## Laboratory Surveillance

All reported cases of DF/DHF were confirmed by one or more laboratory tests; viz. anti-dengue IgM antibody, enzyme linked immunosorbent assay (ELISA), and polymerase chain reaction (PCR).

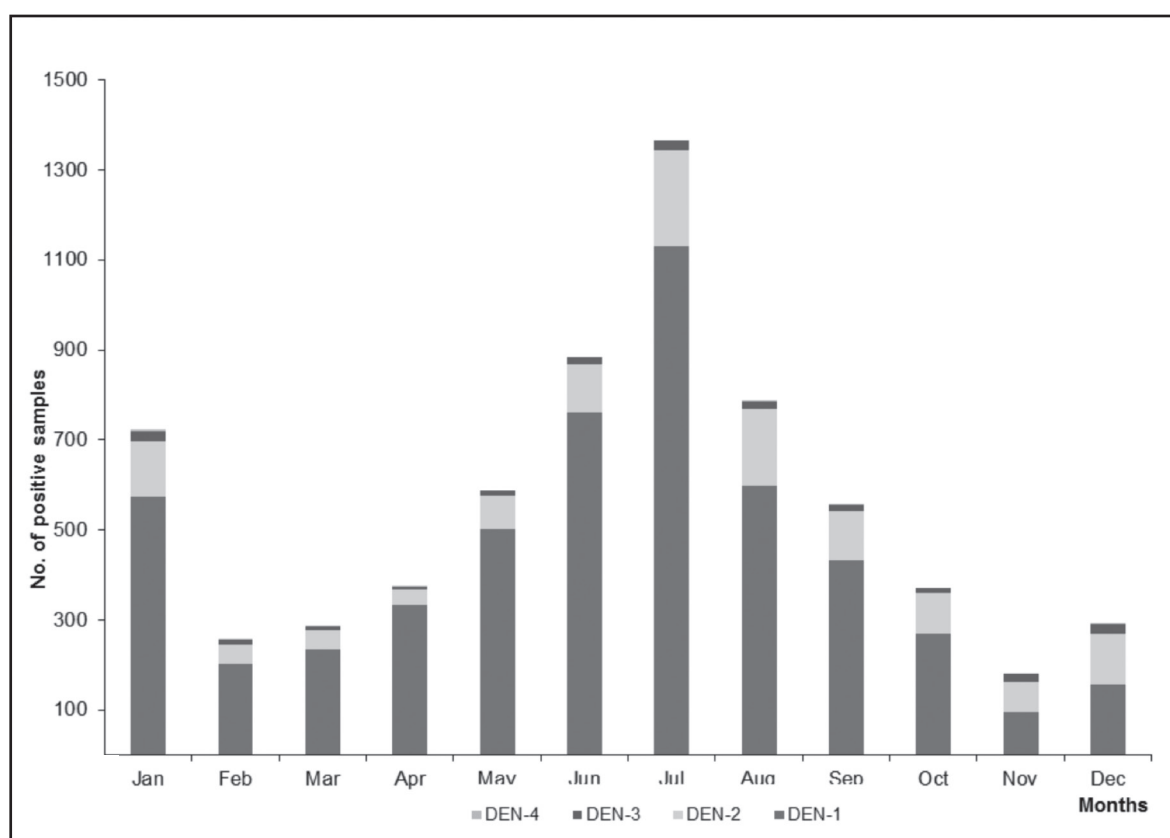
A total of 6,635 blood samples obtained from both inpatients and outpatients tested positive for dengue virus by PCR at the Singapore General Hospital Department of Pathology, Environmental Health Institute, Tan Tock Seng Hospital Department of Pathology and Laboratory Medicine, National University Hospital

Laboratory, Changi General Hospital, KK Women's and Children's Hospital Laboratory and Khoo Teck Puat Hospital Laboratory.

All four dengue serotypes were detected, comprising DENV1 (79.4%), DENV2 (18.0%), DENV3 (2.5%) and DENV4 (0.2%) (Figures 2.4 & 2.5).

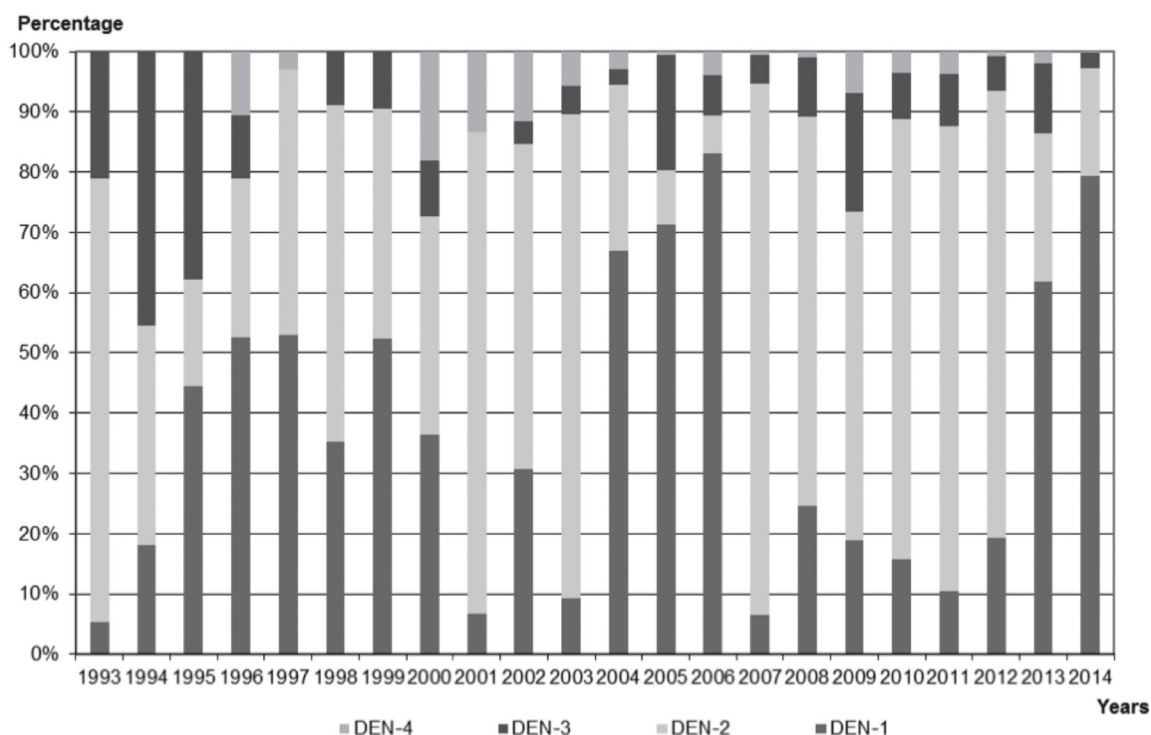
DENV2 was the predominant circulating serotype from 2007 to 2012. DENV1 was found to be the predominant circulating serotype in 2014 (Figure 2.5).

**Figure 2.4**  
Surveillance of dengue virus serotypes, 2014



(Source: Singapore General Hospital Department of Pathology, Environmental Health Institute, Tan Tock Seng Hospital Department of Pathology and Laboratory Medicine, National University Hospital Laboratory, Changi General Hospital, KK Women's and Children's Hospital Laboratory and Khoo Teck Puat Hospital Laboratory)

**Figure 2.5**  
Surveillance of dengue virus serotypes, 1993 – 2014



Source: Singapore General Hospital Department of Pathology, Environmental Health Institute, Tan Tock Seng Hospital Department of Pathology and Laboratory Medicine, National University Hospital Laboratory, Changi General Hospital, KK Women's and Children's Hospital Laboratory and Khoo Teck Puat Hospital Laboratory)

### Aedes mosquito vectors surveillance and control

Suppressing the *Aedes* mosquito vector population is the key to dengue control in the absence of an effective vaccine. The National Environment Agency (NEA) adopts an evidence-based approach for the surveillance and control of *Aedes* vectors.

Surveillance builds on the current regime of inspecting premises for mosquito breeding. Vector surveillance is integrated with epidemiological surveillance and laboratory-based virus surveillance, to generate risk maps that are used to guide vector control efforts, and to communicate risk to the community. It is complemented by adult mosquito sentinel surveillance using Gravitrap, which capture gravid mosquitoes. The Gravitrap-based sentinel surveillance system monitors the *Aedes* mosquito population in HDB housing estates at 34 locations around Singapore. Data collected from the sentinel surveillance system helps to provide insights on mosquito population and distribution, and informs operational deployment.

Source reduction is central to Singapore's dengue vector control efforts. NEA actively engages the community to do their part to prevent mosquito breeding in their premises. Through the Inter-Agency Dengue Taskforce, NEA coordinates source reduction efforts in partnership with stakeholders in the public, private and people sectors. Since 2006, this has been augmented by Intensive Source Reduction Exercise (ISRE) that takes place at the start of the year. This systematic searching and destroying of potential breeding habitats in outdoor areas helps to reduce the vector population to a low level before the onset of the peak season for dengue transmission, which typically falls between May and October.

To control the vector population in clusters, NEA carries out space spraying of insecticides to kill adult mosquitoes, complemented by searching and destroying of mosquito breeding sources. Apart from surveillance, Gravitrap are also used to supplement these measures and to monitor the extent of control efforts.

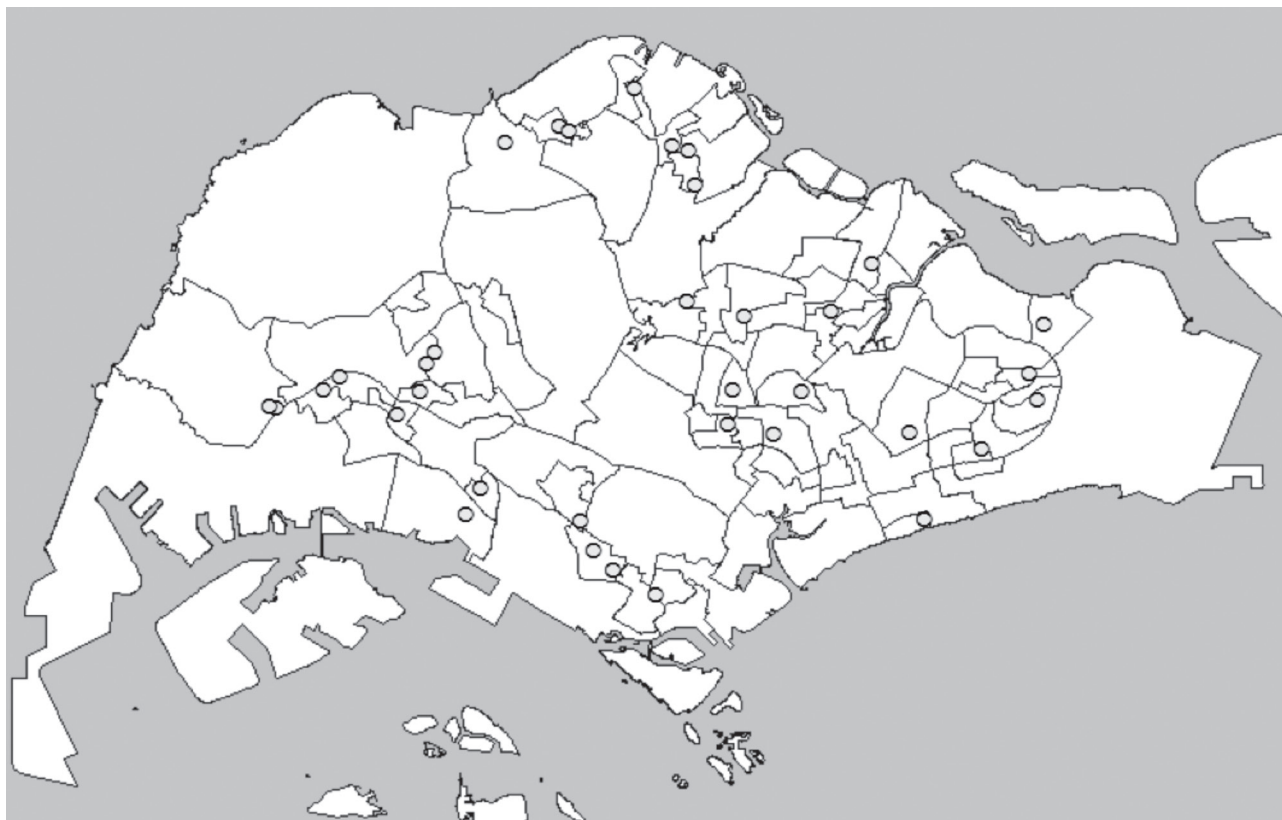
## Situation in 2014

A total of 18,326 cases were reported in 2014. This was 17% lower than 2013, which saw the start of an epidemic associated with the switch of predominant serotype from DENV-2 to DENV-1 and the emergence of a new strain of DENV-1 virus with apparently greater fitness. DENV-1 remained the predominant virus serotype in 2014. Overall, 79.1% of the serotyped dengue cases were DENV-1, followed by DENV-2 (18.3%), DENV-3 (2.4%) and DENV-4 (0.2%).

In 2014, NEA inspected some 3 million premises and surveyed over 110,000 outdoor areas. These include residential premises, construction sites, schools and factories. The distribution of dengue cases and Aedes

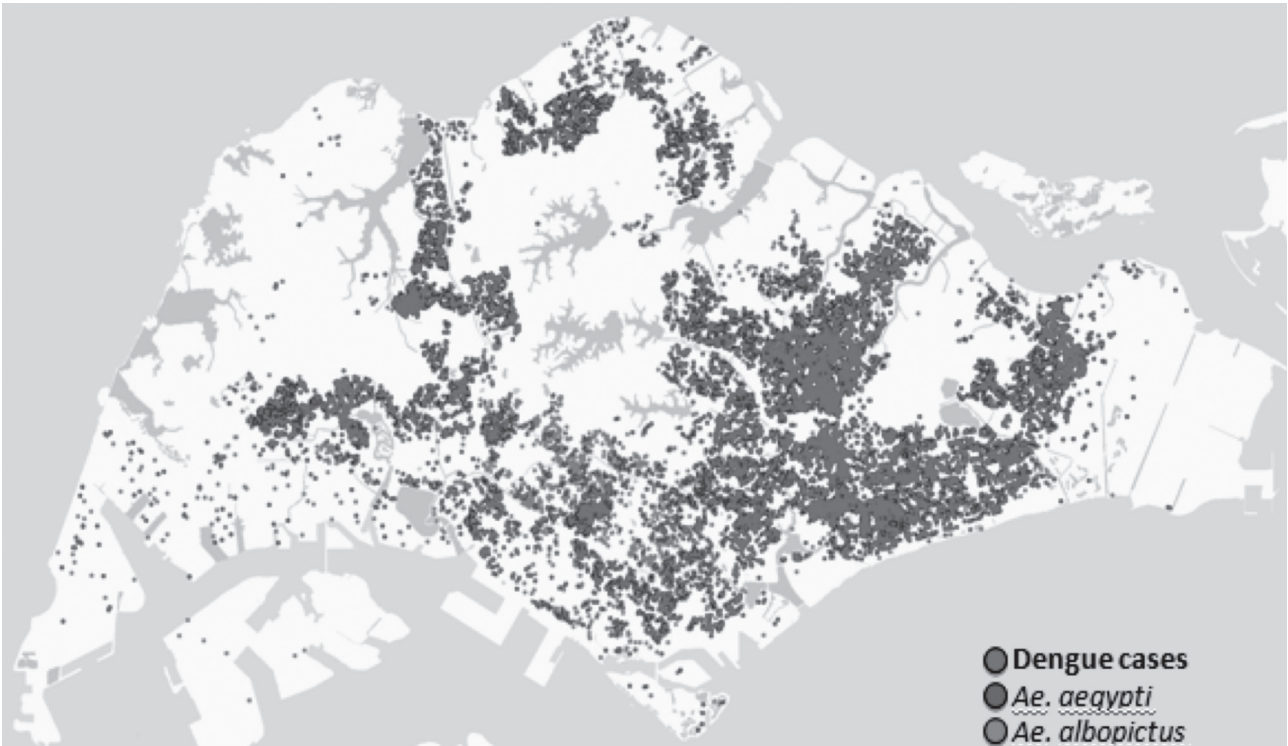
mosquito breeding are shown in Figure 2.7. The overall Aedes House Index (HI) was 0.26%, with compound houses showing the highest HI among the residential premises (Figure 2.8). The top five breeding habitats for *Ae. aegypti* were domestic containers (31.2%), flower pot plate/tray (11.0%), ornamental containers (10.7%), discarded receptacles (2.9%), and puddle / ground depression (2.2%) (Figure 2.9). As for *Ae. albopictus*, the most common breeding habitats were discarded receptacles (11.2%), flower pot plate/tray (10.9%), domestic containers (9.4%), canvas/plastic sheets (5.3%), and closed perimeter drains (4.8%) (Figure 2.10).

**Figure 2.6**  
Distribution of sentinel sites, 2014



(Source: National Environment Agency)

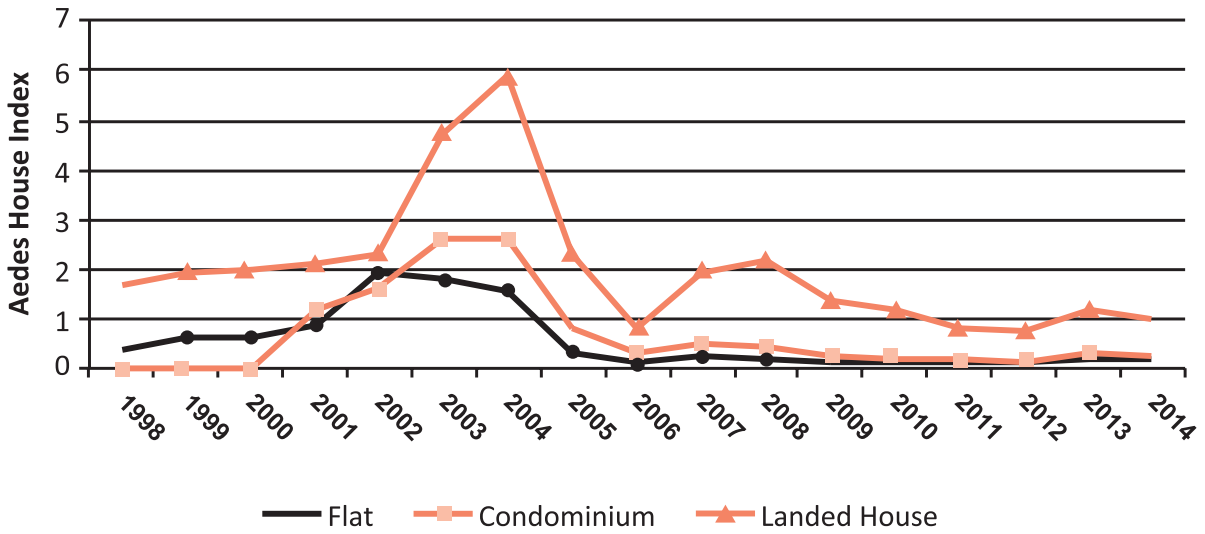
**Figure 2.7**  
Geographical distribution of *Ae. albopictus*, *Ae. aegypti* and dengue cases



(Source: National Environment Agency)

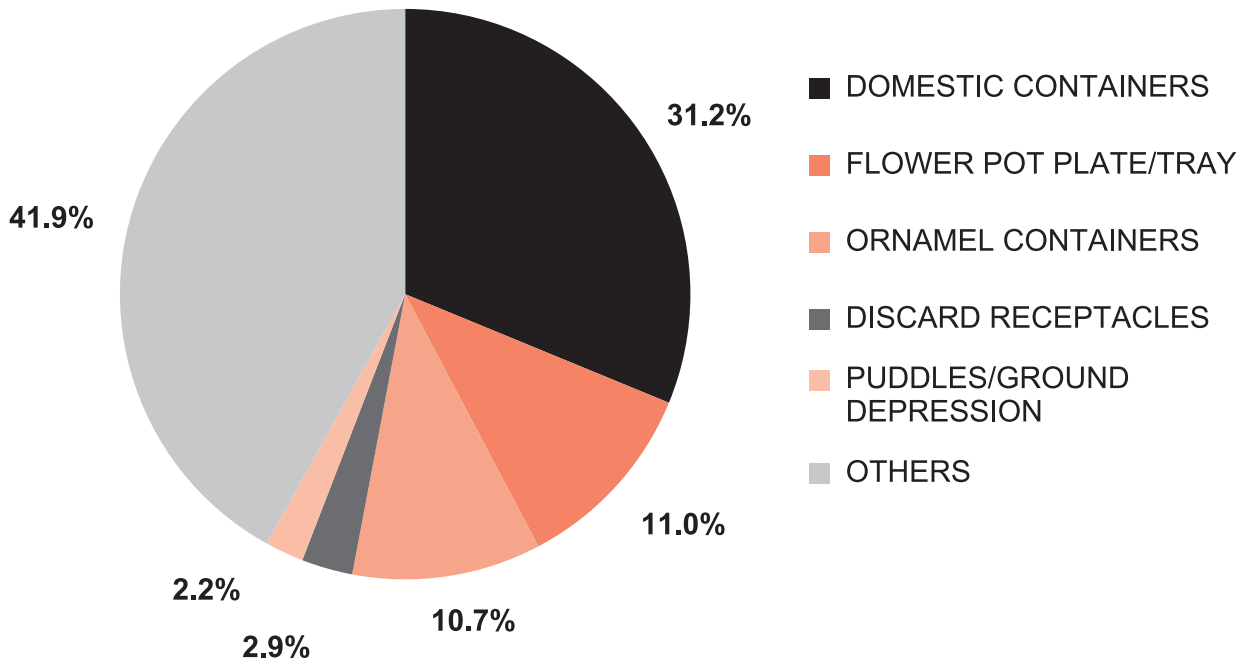
**Figure 2.8**  
Percentage of premises breeding *Aedes* mosquitoes, 1998-2014

**Aedes House Index (1998-2014)**



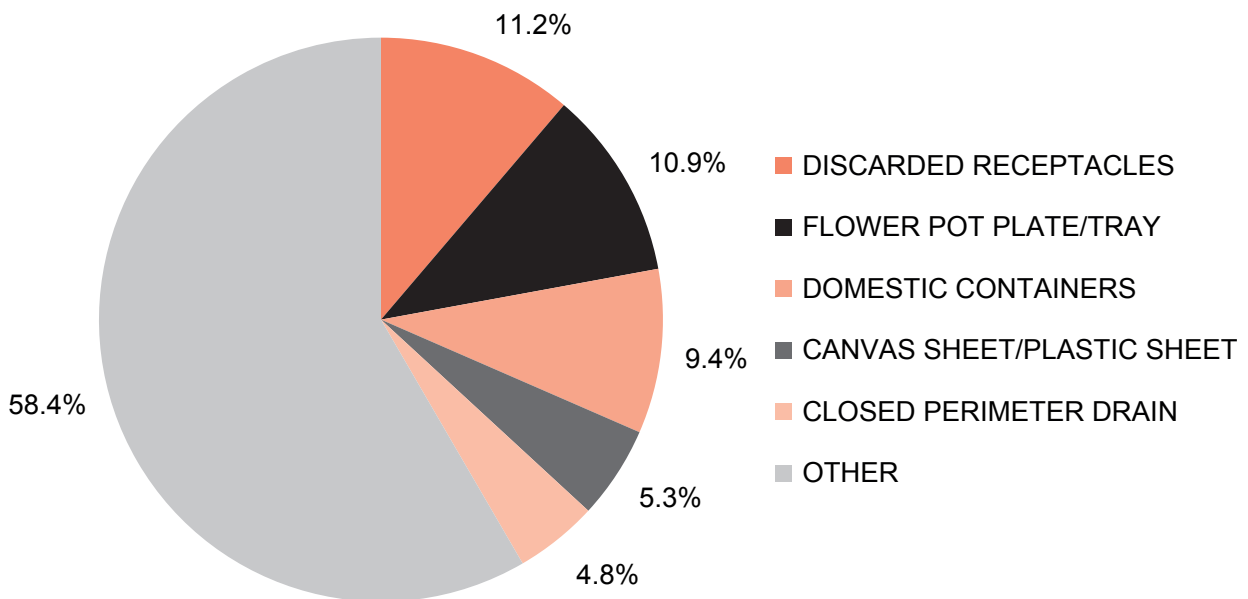
(Source: National Environment Agency)

**Figure 2.9**  
Distribution (%) of *Aedes aegypti* by top 5 breeding habitats, 2014



(Source: National Environment Agency)

**Figure 2.10**  
Distribution (%) of *Aedes albopictus* by top 5 breeding habitats, 2014



The two largest clusters in 2014 are described as follows :

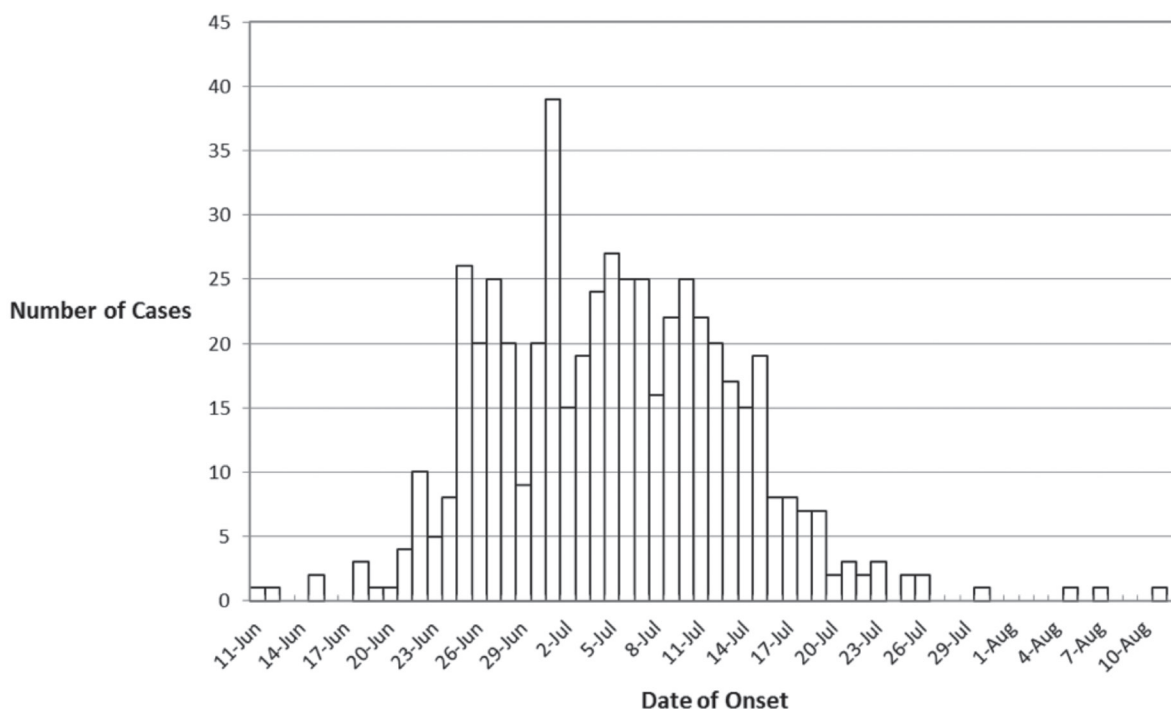
**Outbreak of Dengue fever at Choa Chu Kang Ave 2 (Blk 296, 296A, 296B, 296C, 296D, 296E, 297, 297B, 297C, 297D) / Choa Chu Kang Ave 3 / Choa Chu Kang Ave 5 (Blk 476A, 476B, 476C, 476D, 483, 484, 484A, 484B, 484D, 485, 485A, 485B, 485C, 485D, 486) / CS @ Choa Chu Kang Ave 5 / CS @ Keat Hong CI**

On 16 June 2014, the Ministry of Health was notified of a dengue case residing in 490B Choa Chu Kang Avenue 5. Within two days, another 2 cases were reported. As soon as the cluster was notified, epidemiological investigations and vector control operations were carried out. A total of

534 confirmed cases were identified in the outbreak. All the cases had onset dates between 11 June 2014 and 11 Aug 2014. 305 of the 534 (57.1%) cases had DENV1. The epidemic curve is shown in Figure 2.11.

**Figure 2.11**

**Time distribution of 534 DF/DHF cases in Choa Chu Kang Ave 2 (Blk 296, 296A, 296B, 296C, 296D, 296E, 297, 297B, 297C, 297D) / Choa Chu Kang Ave 3 / Choa Chu Kang Ave 5 (Blk 476A, 476B, 476C, 476D, 483, 484, 484A, 484B, 484D, 485, 485A, 485B, 485C, 485D, 486) / CS @ Choa Chu Kang Ave 5 / CS @ Keat Hong CI**



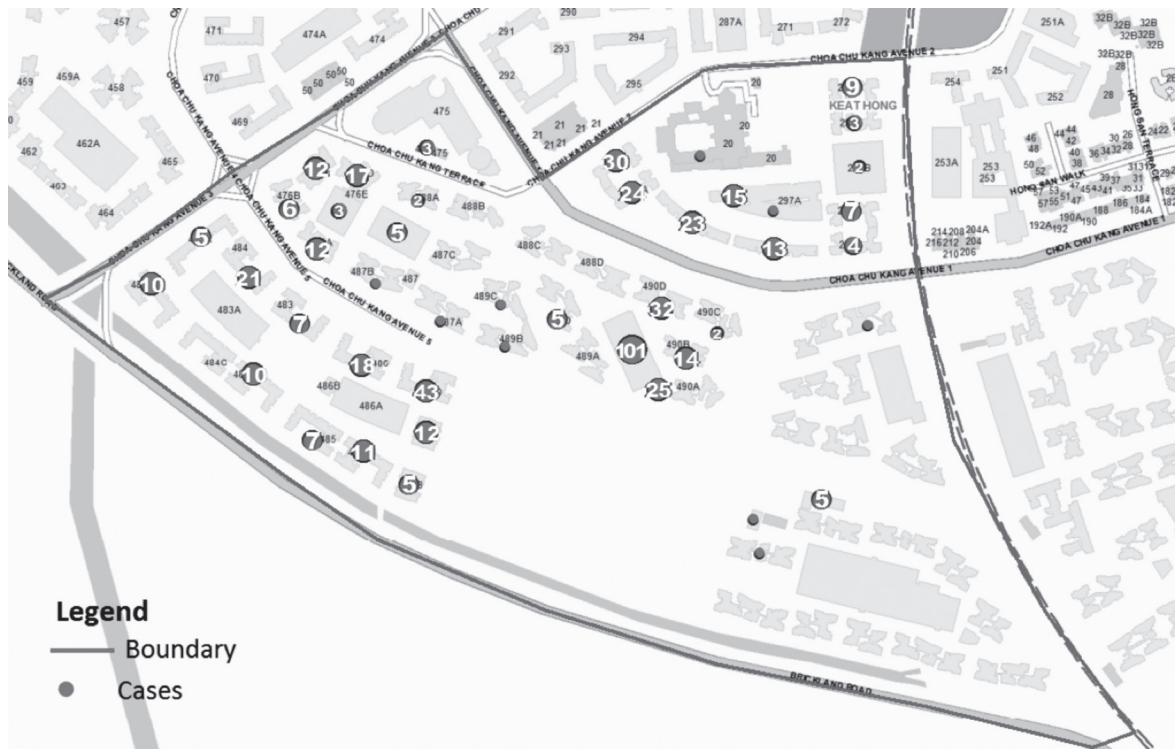
Of the 534 cases, there were 56 (10.5%) students, 31 (5.8%) housewives and 9 (1.7%) retirees. A breakdown by occupation showed that there were 173 (32.3%) construction workers, 26 (4.9%) labourers, 1 (0.2%) domestic helpers, 1 (0.2%) unemployed person and 54 (10.1%) adults working in other occupation. [Note that 183 (34.3%) cases were not tagged with occupation]. The majority of the cases were in the 15-55 years age group (81.8%). The female to male ratio was 1:2.6.

Of these 534 cases, 305 (57.1%) of them were Singaporeans. Figure 2.12 shows the geographical distribution of cases in the cluster.



**Figure 2.12**

**Geographical distribution of 534 DF/DHF cases in Choa Chu Kang Ave 2 (Blk 296, 296A, 296B, 296C, 296D, 296E, 297, 297B, 297C, 297D) / Choa Chu Kang Ave 3 / Choa Chu Kang Ave 5 (Blk 476A, 476B, 476C, 476D, 483, 484, 484A, 484B, 484D, 485, 485A, 485B, 485C, 485D, 486) / CS @ Choa Chu Kang Ave 5 / CS @ Keat Hong Cl (The number in the circle refers to the number of dengue cases within the same building)**



A total of 57 mosquito breeding habitats were identified and destroyed. 45.6% of the breeding habitats were found in residential premises including toilet bowl cistern, pails, domestic containers, flower pot/vase, dish tray, etc., 40.4% in public areas including discarded receptacles, drains, ground depression, lamp post, etc. and 14% in construction sites including drain, material for construction left unmaintained, etc. Three major

breeding habitats were detected at a gully trap in the Town Council area (100 larvae), a toilet bowl cistern (50 larvae) within residential area and a safety helmet (50 larvae) in the construction site within the cluster. Overall, the breeding detected comprised of 64.9% *Aedes aegypti*, 33.3% *Aedes albopictus* and 1.8% of *Aedes albopictus* and *Culex*.

**Outbreak of Dengue fever at CS @ Circuit Lk / Circuit Rd (Blk 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 54, 55, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 79, 85, 87) / Paya Lebar Way (Blk 91, 93, 120, 124) / Pipit Rd (Blk 53, 54, 55, 56, 90, 92, 92A, 94)**

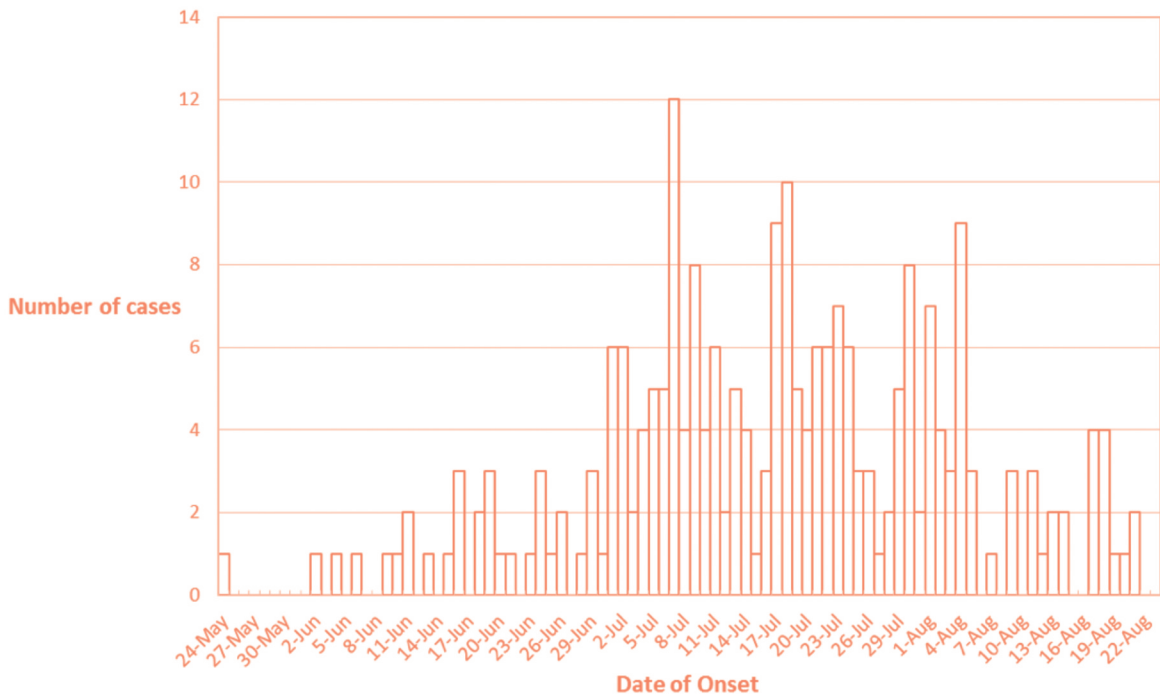
On 29 May 2014, the Ministry of Health was notified of a dengue case residing at 60 Circuit Road. Within two weeks, another 3 cases within the vicinity were reported. As soon as the cluster was notified, epidemiological investigations and vector control operations were

carried out. A total of 236 dengue cases were identified in the outbreak. All the cases had onset dates between 24 May 2014 and 21 Aug 2014. The epidemic curve is shown in Figure 2.13.



**Figure 2.13**

**Time distribution of 236 DF/DHF cases in CS @ Circuit Lk / Circuit Rd (Blk 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 54, 55, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 79, 85, 87) / Paya Lebar Way (Blk 91, 93, 120, 124) / Pipit Rd (Blk 53, 54, 55, 56, 90, 92, 92A, 94)**



Of the 236 cases, there were 3 (1.3%) children under 4 years of age, 28 (11.9%) students, 15 (6.4%) housewives and 8 (3.4%) retirees. A breakdown by occupation showed that the cases comprised of 16 (6.8%) labourers, 13 (5.5%) construction workers, 40 (17.0%) working adults in other occupation and 2 (0.8%) unemployed persons. [Note that 111 (47%) of the cases were not tagged with occupation.]

The majority (80.5%) of the cases were in the 15-60 years age group. The female to male ratio was 1:1.4. Of these 236 cases, 195 (82.6%) were Singaporeans and Permanent Residents. The geographical distribution of cases in the cluster is shown in Figure 2.14.

**Figure 2.14**

Geographical distribution of 236 DF/DHF cases in CS @ Circuit Lk / Circuit Rd (Blk 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 54, 55, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 79, 85, 87) / Paya Lebar Way (Blk 91, 93, 120, 124) / Pipit Rd (Blk 53, 54, 55, 56, 90, 92, 92A, 94)  
 (The number in the circle refers to the number of dengue cases within the same building)



A total of 27 mosquito breeding habitats were detected and destroyed. 55.6% of the total breeding habitats detected were in residential premises including domestic containers, flower pot, vase, pail, etc. and 44.4% in public areas including drains, inspection chamber, pail, etc. Three profuse breeding habitats each of 200 larvae were detected in tyres/rims/canvas sheet within residential premises, and two inspection

chambers in the Town Council areas. Overall, the breeding's comprised 55.6% *Aedes albopictus*, 29.6% of *Aedes albopictus* and *Aedes aegypti*, 11.1% of *Aedes aegypti* and 3.7% of *Aedes albopictus* and *Culex*.

In terms of DENV serotype, 107(45.3%) cases had DENV2 and 21 (8.9%) cases had DENV1.

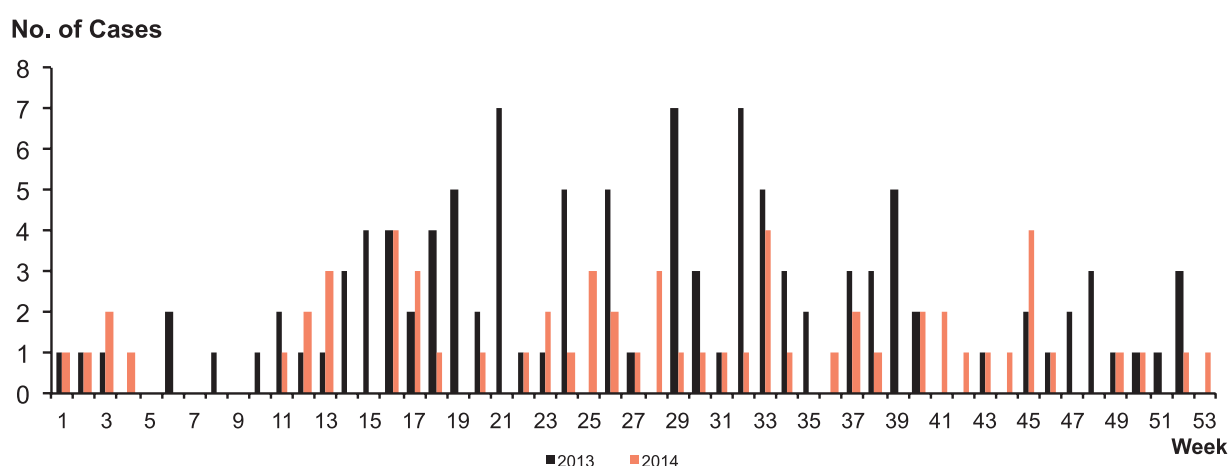
## MALARIA

Malaria is a disease caused by a protozoan parasite, *Plasmodium*. The disease is transmitted via the bite of an infective female *Anopheles* mosquito. There are four species that cause disease in humans, namely *P. vivax*, *P. malariae*, *P. falciparum* and *P. ovale*. In recent years, *P. knowlesi* – a species that causes malaria among monkeys and occurs in certain forested areas of South-East Asia – has also caused several human

cases of malaria. Symptoms of malaria include fever, headache, chills and vomiting.

In 2014, a total of 62 laboratory-confirmed cases were reported, a decrease of 44% compared to the 111 cases reported in 2013 (Figure 2.15). All 62 cases were imported.

**Figure 2.15**  
E-weekly distribution of reported malaria cases, 2013-2014



The incidence rate was highest in the 25 - 34 years age group, with an overall male to female ratio of 7.5:1 (Table 2.12). Among the three major ethnic groups,

Indians had the highest incidence rate, followed by Chinese and Others (Table 2.13).

**Table 2.12**  
Age-gender distribution and age-specific incidence rate of reported malaria cases<sup>^</sup>, 2014

Age	Male	Female	Total (%)	Incidence rate per 100,000 population*
0 - 4	0	0	0 (0.0)	0.0
5 - 14	1	0	1 (2.0)	0.2
15 - 24	7	1	8 (15.7)	1.0
25 - 34	23	2	25 (49.0)	2.0
35 - 44	8	1	9 (17.6)	0.9
45 - 54	3	2	5 (9.8)	0.7
55 - 64	3	0	3 (5.9)	0.5
65+	0	0	0 (0.0)	0.0
<b>Total</b>	<b>45</b>	<b>6</b>	<b>51 (100.0)</b>	<b>0.9</b>

<sup>^</sup>Excluding 7 foreigners seeking medical treatment in Singapore and 4 tourists.

\*Rates are based on 2014 estimated mid-year population.

(Source: Singapore Department of Statistics)

**Table 2.13**  
Ethnic-gender distribution and ethnic-specific incidence rate of reported malaria cases<sup>^</sup>, 2014

	Male	Female	Total (%)	Incidence rate per 100,000 population*
Singapore Resident				
Chinese	4	0	4 (7.8)	0.1
Malay	0	0	0 (0.0)	0.0
Indian	5	0	5 (9.8)	1.4
Others	0	1	1 (2.0)	0.8
Foreigner	36	5	41 (80.4)	2.6
<b>Total</b>	<b>45</b>	<b>6</b>	<b>51 (100.0)</b>	<b>0.9</b>

<sup>^</sup>Excluding 7 foreigners seeking medical treatment in Singapore and 4 tourists.

\*Rates are based on 2014 estimated mid-year population.

(Source: Singapore Department of Statistics)

### Malaria parasite species

The distribution of the cases by parasite species was *P. falciparum* (4.9%), *P. ovale* (3.2%) and *P. malariae* (1.6%) (Table 2.14). *P. vivax* (75.8%), *P. falciparum* (14.5%), *P. knowlesi* (2.14%).

**Table 2.14**  
Classification of reported malaria cases by parasite species, 2014

Classification	Parasite species					Total (%)
	P.v.	P.f.	P.o.	P.m.	P.k.	
Imported**	47	9	2	1	3	62 (100.0)
Introduced	0	0	0	0	0	0 (0.0)
Indigenous	0	0	0	0	1	0 (0.0)
Cryptic	0	0	0	0	0	0 (0.0)
Induced	0	0	0	0	0	0 (0.0)
<b>Total</b>	<b>47</b>	<b>9</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>62 (100.0)</b>

P.v. - Plasmodium vivax P.f. - Plasmodium falciparum P.o. - Plasmodium ovale

P.m. - Plasmodium malariae P.k. - Plasmodium knowlesi

\*\*Including relapsed cases that were imported.

### Imported malaria cases

The majority of cases who had acquired malaria overseas were infected in India (61.3%) and Indonesia (9.7%). *P. vivax* accounted for 97.4% and 83.3% of the infections acquired in India and Indonesia

respectively and *P. falciparum* accounted for 100.0% and 16.7% of the infections acquired in the African region and Indonesia respectively (Table 2.15).

**Table 2.15**  
**Imported malaria cases by country of origin and by parasite species, 2014**

Classification	Parasite species					Total (%)
	P.v.	P.f.	P.o.	P.m.	P.k.	
<b>Southeast Asia</b>						
Brunei Darussalam	0	0	0	0	0	0 (0.0)
Indonesia	5	1	0	0	0	6 (9.7)
Malaysia	1	1	0	0	3	5 (8.1)
Myanmar	0	0	0	1	0	1 (1.6)
<b>South Asia</b>						
Bangladesh	1	0	0	0	0	1 (1.6)
India	37	1	0	0	0	38 (61.3)
Pakistan	1	0	0	0	0	1 (1.6)
<b>Africa</b>						
Cameroon	0	1	0	0	0	1 (1.6)
Ghana	0	1	0	0	0	1 (1.6)
Ivory Coast	0	1	0	0	0	1 (1.6)
South Africa	0	2	0	0	0	1 (1.6)
<b>Other countries</b>						
China	0	0	2	0	0	2 (3.2)
Cook Islands	0	1	0	0	0	1 (1.6)
Taiwan	1	0	0	0	0	0 (0.0)
Papua New Guinea	1	0	0	0	0	2 (3.2)
<b>Total</b>	<b>47</b>	<b>9</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>62 (100.0)</b>

*P.v.* - *Plasmodium vivax* *P.f.* - *Plasmodium falciparum* *P.o.* - *Plasmodium ovale*  
*P.m.* - *Plasmodium malariae* *P.k.* - *Plasmodium knowlesi*

Most of the cases (58.1%) had onset of fever within three weeks of entry into Singapore (Table 2.16). For *P. vivax* malaria, 44.7% of cases did not develop symptoms until more than six weeks after entry.

**Table 2.16**  
**Imported malaria cases by interval between period of entry and onset of illness and by parasite species, 2014**

Interval in weeks	Parasite species					Total (%)
	P.v.	P.f.	P.o.	P.m.	P.k.	
<2	22	8	0	0	2	32 (51.6)
2 – 3	2	1	0	0	1	4 (6.5)
4 – 5	1	1	0	0	3	5 (8.1)
6 – 7	1	0	0	0	0	1 (1.6)
8 – 9	1	0	0	0	0	1 (1.6)
10 – 11	1	0	0	0	0	1 (1.6)
12 – 13	0	0	0	0	0	0 (0.0)
14 – 15	1	0	1	0	0	2 (3.2)
16 – 17	0	0	0	0	0	0 (0.0)
18 – 19	2	0	0	0	0	2 (3.2)
20 – 23	2	0	0	0	0	2 (3.2)
24 – 27	3	0	0	0	0	3 (4.8)
28 – 31	1	0	0	0	0	1 (1.6)
32 – 35	2	0	0	0	0	2 (3.2)
36 – 39	2	0	0	0	0	2 (3.2)
40+	6	0	1	1	0	8 (12.9)
<b>Total</b>	<b>47</b>	<b>9</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>62 (100.0)</b>

*P.v.* - *Plasmodium vivax* *P.f.* - *Plasmodium falciparum* *P.o.* - *Plasmodium ovale*  
*P.m.* - *Plasmodium malariae* *P.k.* - *Plasmodium knowlesi*

The 62 imported cases comprised 10 Singapore residents (16.1%), 32 work permit/employment pass holders (59.7%), 1 student pass holders (1.6%), 8 foreigners residing in Singapore (16.1%), 7 foreigners seeking medical treatment in Singapore (11.3%) and 4 tourists (6.5%) (Table 2.17).

**Table 2.17**  
**Classification of imported malaria cases by population group, 2013-2014**

Classification	2013		2014	
	Cases	%	Cases	%
<b>Local Residents</b>				
Singapore residents	16	14.6	10	16.1
Work permit/Employment pass holders	58	52.7	32	51.6
Student pass holders	2	1.8	1	1.6
Other foreigners	11	10.0	8	12.9
Foreigners seeking medical treatment	9	8.2	7	11.3
Tourists	14	12.7	4	6.5
<b>Total</b>	<b>110</b>	<b>100.0</b>	<b>62</b>	<b>100.0</b>

The majority of Singapore residents who contracted malaria whilst travelling overseas were on holiday. All of the cases admitted that they did not take/complete chemoprophylaxis (Table 2.18 and 2.19).

**Table 2.18**  
**Purpose of travel for Singapore residents who contracted malaria overseas, 2010-2014**

	2010	2011	2012	2013	2014
<b>Purpose of Travel</b>					
Social visits/holidays	26	10	24	10	5
Business	6	4	1	3	4
Military service	0	1	1	0	0
Volunteer/Missionary work	0	0	1	2	1
Employment	3	1	2	1	0
<b>Total</b>	<b>35</b>	<b>16</b>	<b>29</b>	<b>16</b>	<b>10</b>

**Table 2.19**  
**History of chemoprophylaxis for Singapore residents who contracted malaria overseas, 2010 - 2014**

	2010	2011	2012	2013	2014
<b>Chemoprophylaxis</b>					
Took complete chemoprophylaxis	0	0	1	0	0
No chemoprophylaxis	35	15	27	16	10
Irregular/incomplete chemoprophylaxis	0	1	1	0	0
<b>Total</b>	<b>35</b>	<b>16</b>	<b>29</b>	<b>16</b>	<b>10</b>

**Table 2.20**  
**Total number of notifications received for malaria cases, 2010-2014\***

Age Group	2010		2011		2012		2013		2014	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0 – 4	0	2	0	1	0	0	0	0	0	0
5 – 14	0	4	0	1	0	2	0	1	0	1
15 – 24	7	37	0	35	0	26	1	27	0	8
25 – 34	2	42	0	33	0	45	0	39	0	25
35 – 44	0	16	0	10	0	9	0	12	0	9
45 – 54	0	8	0	5	0	10	0	3	0	5
55 - 64	0	3	0	6	0	2	0	5	0	3
65+	1	3	0	1	0	4	0	0	0	0
<b>Total</b>	<b>10</b>	<b>115</b>	<b>0</b>	<b>92</b>	<b>0</b>	<b>98</b>	<b>1</b>	<b>87</b>	<b>0</b>	<b>51</b>

\*excludes tourists and foreigners seeking medical treatment in Singapore