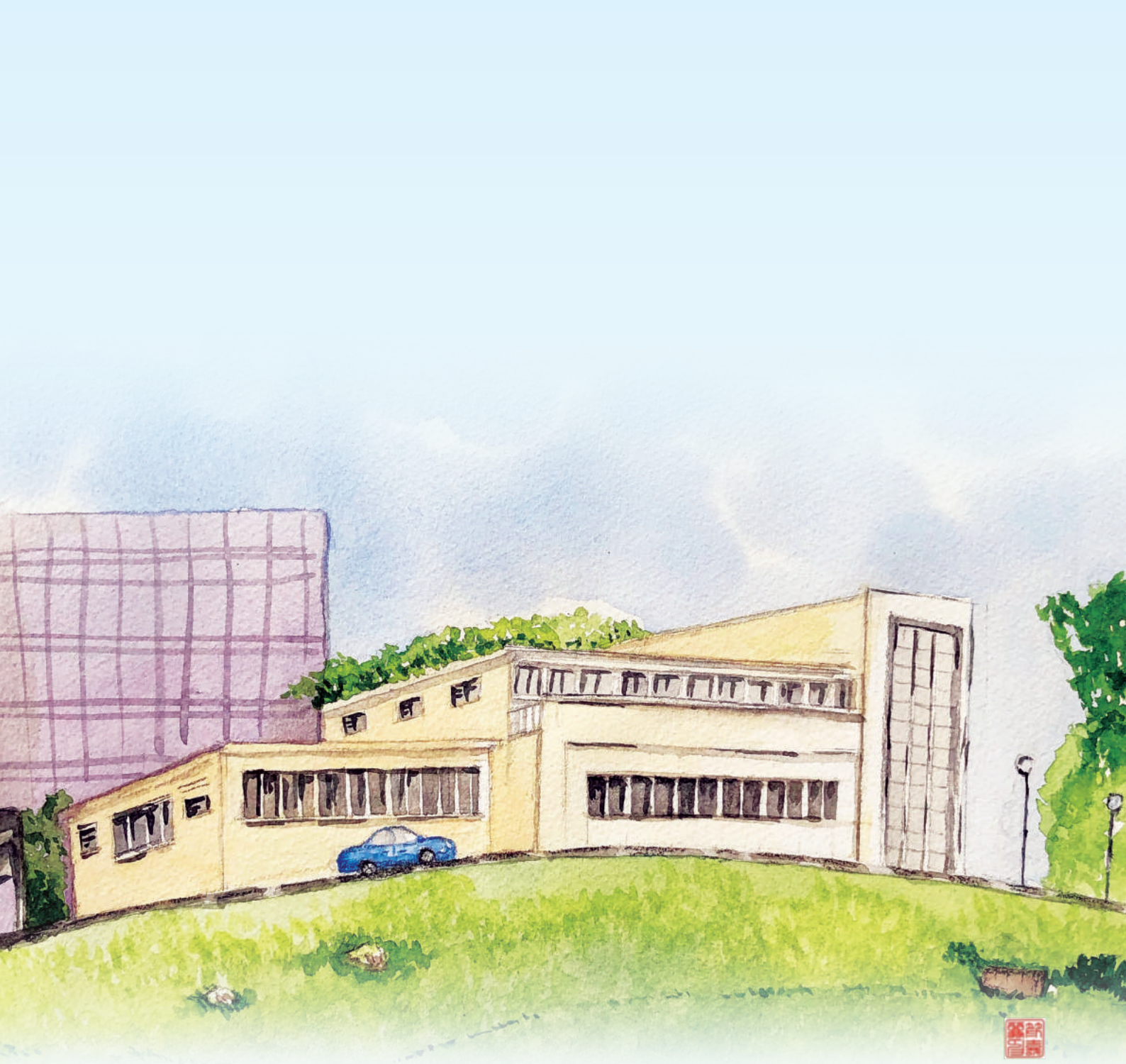


Communicable Diseases Surveillance SINGAPORE 2018

Front cover: King Edward VII Hall, Ministry of Health. Kelly Foo. 2019

ISSN 0217-7854

Contents

FOREWORD

We are pleased to present our Ministry of Health's "Communicable Diseases Surveillance, Singapore 2018" report. This annual publication provides a comprehensive review of the epidemiological features of the notifiable infectious diseases reported during the year 2018. Outbreaks identified through routine surveillance together with the prevention and control measures are described. In addition, we have also evaluated the coverage and efficacy of our national childhood immunisation programme.

2018 has been a significant year in public health for Singapore. Firstly, together with other government agencies, we hosted an expert team from the World Health Organization (WHO) in a joint external evaluation (JEE) of our core capacities for implementing health security measures under the International Health Regulations (2005) to safeguard global public health. The JEE team assessed that Singapore had a highly developed capacity to detect and respond to potential public health emergencies.

Secondly, Singapore was verified by the WHO based on relevant documentation to have eliminated endemic transmission of measles. Maintaining high MMR vaccination coverage remains one of the key strategies to ensure Singapore remains free from endemic transmission of measles.

Thirdly, on the immunisation front, MOH has established the National Adult Immunisation Program (NAIS) to increase the awareness and facilitate the take-up of important vaccinations for adults for personal protection and prevention against vaccine preventable diseases. The NAIS is intended to serve as a useful reference for the public to be aware of important vaccination for adults, and for healthcare professionals in recommending these vaccinations to their patients.

Our colleagues in clinical practice, the laboratories and sister agencies have been valuable partners working with us on communicable diseases surveillance. We would like to express our gratitude to the many professionals working in our medical and public health community for their dedicated support in our common goal of safeguarding Singapore against infectious disease threats.

We hope that you will find this annual report useful, and look forward to your continued support and cooperation as we face future public health challenges together.

Dr Derrick Heng
Group Director (Public Health Group)
Ministry of Health

CHAPTER 1

OVERVIEW

Singapore is an island city state with a population of about 5.6 million. This section presents the highlights of the surveillance and epidemiological investigation findings of the communicable diseases in 2018 and an evaluation of our national childhood immunisation programme.

POPULATION PROFILE

In 2018, Singapore had an estimated population of 5.64 million, with a resident population of 3.99 million. The female-to-male ratio in the resident population was 1.04. The ethnic distribution in the resident population showed a Chinese majority of 74.3%, followed by Malays and Indians at 13.4% and 9.1% respectively.

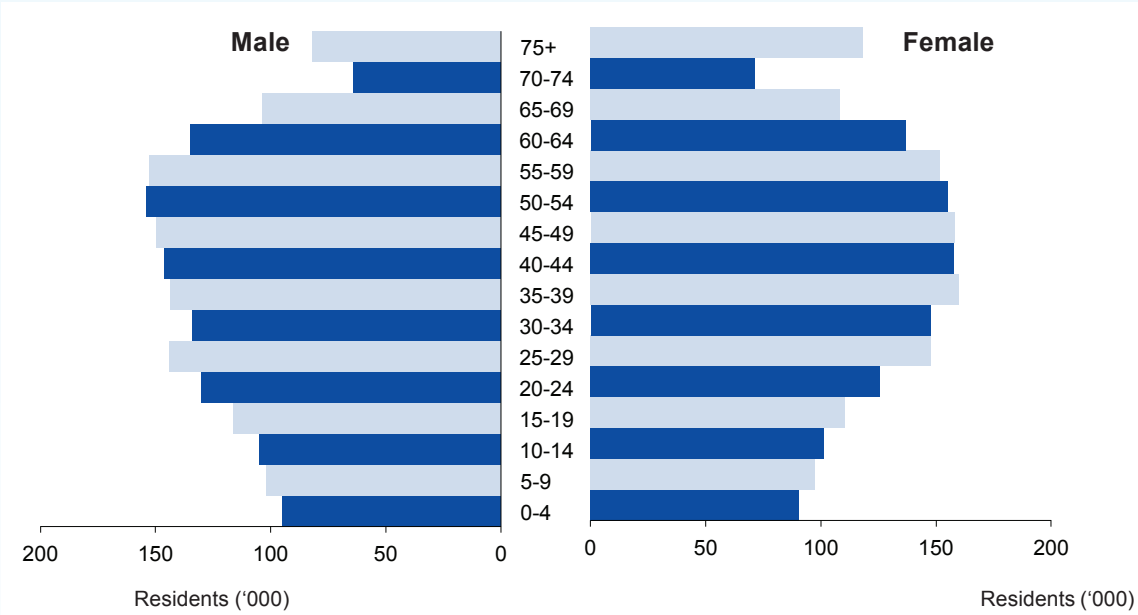
The ageing pattern of Singapore's population is shown in the age pyramid below. The proportion of residents aged 15 to 64 years increased from 71% in 1990 to 72% in 2018 while the proportion of children under 15 years has steadily declined from 23% in 1990 to 15% in 2018. Currently 14% of Singapore residents are aged 65 years and above, compared to 6% in 1990.

Demographic profile (mid-year estimates), 2018

Total population	5.64 million
Resident population	3.99 million
Gender ratio (female to male)	1.04
Ethnic distribution	(%)
Chinese	74.3
Malay	13.4
Indian	9.1
Others	3.2

(Source: Singapore Department of Statistics)

Age distribution of resident population, 2018



(Source: Singapore Department of Statistics)

COMMUNICABLE DISEASES SITUATION

All notifications of infectious diseases received during the year 2018 have been included in this report. It should however be noted that notifications of cases seeking medical treatment in Singapore for infectious diseases have been excluded from selected morbidity statistics which reflect the status in Singapore citizens, Singapore permanent residents and foreigners residing in Singapore (i.e. non-citizens who have not been granted permanent residence status).

Air/droplet-borne diseases

The diseases covered in Chapter 2 include, *haemophilus influenzae* type B disease, hand, foot and mouth disease, influenza, measles, meningococcal infection, mumps, pertussis, pneumococcal disease (invasive), rubella, tetanus, conjunctivitis, and chickenpox.

There were 40,217 notified cases of hand, foot and mouth disease in 2018, an increase of 19.5% from 33,663 cases in 2017. A total of 34 measles cases were notified in 2018, compared to 70 cases in 2017. The number of rubella cases reported in 2018 was 10, compared to 15 cases in 2017. There were also 474 notified cases of mumps in 2018, compared to 524 cases in 2017.

Vector-borne diseases

The diseases covered in Chapter 3 include chikungunya fever, dengue fever/dengue haemorrhagic fever, leptospirosis, malaria, murine typhus and Zika virus infection.

All vector-borne diseases were investigated promptly upon notification. The Ministry of Health worked closely with the National Environment Agency, and intensive vector control operation remained the key strategy for prevention and control of vector-borne outbreaks.

A total of 3,283 dengue fever/dengue haemorrhagic fever cases were notified in 2018, compared to 2,767 cases in 2017. The majority of the cases were infected locally and dengue virus type 2 was the predominant circulating strain. There were also 15 chikungunya fever cases notified in 2018 compared to 29 cases in 2017.

One case of Zika virus infection was notified in 2018 compared with 67 cases in 2017. Singapore identified its first imported case of Zika virus infection in Year 2016 in a traveler returning from Brazil which led to a major local outbreak at Aljunied in the second half of the year.

In addition, there were 35 notified cases of malaria in 2018; all had acquired the infection overseas.

Food-borne diseases

The diseases covered in Chapter 4 include acute diarrhoeal illness, botulism, campylobacteriosis, cholera, enteric fevers, hepatitis A, hepatitis E, salmonellosis, and food poisoning.

Although most cases were sporadic in nature, strict measures were implemented to ensure that high standards of personal, food and environmental hygiene were maintained.

Campylobacteriosis and non-typhoidal salmonellosis contributed significantly to the burden of food-borne illness. There were 427 cases of campylobacteriosis and 1,620 cases of salmonellosis reported in 2018.

The incidence of enteric fevers (typhoid and paratyphoid) showed a 27.2% decrease from 81 cases in 2017 to 59 cases in 2018. There were 75 cases of acute hepatitis A notified in 2018, a decrease of 7.4% compared to 81 cases in 2017.

Blood-borne and sexually transmitted diseases

The diseases covered in Chapter 5 include hepatitis B, hepatitis C, human immunodeficiency virus infection/acquired immune deficiency syndrome, and other sexually transmitted infections.

The three most common sexually transmitted infections (STIs) notified in Singapore in 2018 were chlamydia, gonorrhoea and syphilis. The overall incidence rate of STIs was 183 cases per 100,000 population. Chlamydia was the most common infection with an incidence rate of 48.2 cases per 100,000 population.

The number of HIV/AIDS infection notifications was 313 in 2018 compared to 434 in 2017.

Other diseases

The diseases covered in Chapter 6 include legionellosis, leprosy, melioidosis, tuberculosis (TB), healthcare-associated outbreaks, and severe illness and death from possibly infectious causes.

In 2018 a total of 2,182 new cases of TB were reported. They comprised 1,547 Singapore residents and 635 long staying foreigners. This represented a decrease of 0.4% from 2017.

There were 22 cases of legionellosis and 34 cases of melioidosis notified in 2018.

Childhood immunisation

Chapter 7 provides the summary of the implementation of the National Childhood Immunisation Programme in 2018. The immunisation coverage among children against TB, diphtheria, pertussis and tetanus, poliomyelitis, *haemophilus influenzae* type b, measles, mumps, rubella, pneumococcal disease and human papillomavirus is included.

Summary of disease notifications

A summary of all the infectious disease notifications received by the Ministry of Health in Singapore over the 20 year period from 1999 to 2018 (by the number of notifications and by incidence rate per 100,000 population) has been tabulated in the next two pages for readers' easy reference.

Infectious disease notifications and deaths in 2018

	No. of notifications	No. of deaths+	Crude incidence rate*	Mortality rate*
Air/Droplet-borne Diseases				
Hand, Foot and Mouth Disease	40,217	0	713.2	0
Measles	34	0	0.6	0
Meningococcal Infection	9	0	0.2	0
Mumps	474	0	8.4	0
Rubella	10	0	0.2	0
Vector-borne Diseases				
Chikungunya Fever	15	0	0.3	0
Dengue Fever/Dengue Haemorrhagic Fever	3,283	5^	58.2	0.1
Malaria	35	0	0.6	0
Zika virus infection	1	0	0	0
Food-borne Diseases				
Campylobacteriosis	427	0	7.6	0
Cholera	2	0	0	0
Hepatitis A	75	0	1.3	0
Hepatitis E	54	0	1.0	0
Paratyphoid	16	0	0.3	0
Salmonellosis	1,620	0	28.7	0
Typhoid	43	0	0.8	0
Blood-borne and Sexually Transmitted Diseases				
Hepatitis B	52	0	0.9	0
Hepatitis C	14	0	0.2	0
HIV/AIDS**	313	74	7.8	1.9
STIs	10,316	0	183.0	0
Other Diseases				
Tuberculosis***	2,182	28	39.0	0.7
Leprosy	6	0	0.1	0
Legionellosis	22	0	0.4	0
Melioidosis	34	0	0.6	0

+Source: Registry of Births & Deaths, and Ministry of Health.
*Rates per 100,000 population, based on estimated mid-year total population, 2018.
(Source: Singapore Department of Statistics)
** Referred to Singaporeans/PR cases.
*** Referred to Singaporeans/PR cases and long staying foreigners.
^ Excluded one locally acquired dengue infection who passed away overseas

INFECTIOUS DISEASE NOTIFICATIONS IN SINGAPORE, 1999-2018

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
										Number of Notifications									
Air/Droplet-Borne Diseases																				
Diphtheria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Haemophilus influenzae type b	-	1	5	0	3	2	5	4	1	1	4	5	2	1	10	6	3	2	8	5
Hand, Foot and Mouth Disease	1408	6402	5187	16228	5603	6411	15257	15282	20003	29686	17278	30878	20687	37125	31741	22171	28216	42154	33663	40217
Measles	65	141	61	57	33	96	33	28	15	18	13	49	148	38	46	142	42	136	70	34
Meningococcal infection	-	-	4	13	11	7	5	10	5	6	5	7	6	0	3	9	6	5	12	9
Mumps	6384	5981	1399	1090	878	1003	1004	844	780	801	631	452	501	521	495	478	473	540	524	474
Pertussis	-	-	-	-	-	0	0	3	38	33	13	8	29	24	17	21	57	85	79	108
Pneumococcal disease (Invasive)	-	-	-	-	-	-	-	-	-	-	157	166	148	163	167	147	139	131	156	134
Rubella	432	312	242	152	88	141	139	90	83	180	178	158	110	64	48	17	15	12	15	10
Vector-Borne Diseases																				
Chikungunya Fever	-	-	-	-	-	-	-	-	-	718	341	26	12	22	1059	182	42	36	29	15
Dengue fever/Dengue haemorrhagic fever	1355	673	2372	3945	4788	9459	14209	3127	8826	7031	4497	5363	5330	4632	22170	18326	11294	13085	2767	3283
Malaria	316	266	229	175	118	152	166	181	155	152	172	190	149	143	111	62	47	31	39	35
Zika virus infection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	458	67	1
Food-Borne Diseases																				
Campylobacteriosis	343	231	105	50	144	131	241	236	170	177	261	320	372	443	397	435	420	442	495	427
Cholera	11	10	8	2	2	11	1	0	7	1	4	4	2	2	2	2	3	2	3	2
Enteric fever																				
Typhoid	48	80	82	49	32	52	69	60	67	84	69	82	71	84	84	58	49	51	65	43
Paratyphoid	15	21	34	25	9	32	26	23	33	29	28	38	33	57	23	19	27	19	16	16
Hepatitis A	88	77	60	236	55	67	98	146	88	107	89	68	66	108	88	73	50	48	81	75
Hepatitis E	20	17	3	24	17	24	36	31	35	54	90	112	97	104	55	68	59	74	76	54
Salmonellosis	-	99	198	129	192	345	296	380	309	719	1144	1480	1374	1499	1735	1920	1988	2212	2010	1620
Blood-Borne & Sexually Transmitted Diseases																				
Hepatitis B	140	117	80	63	64	98	83	96	79	87	69	65	73	58	57	48	52	47	38	54
Hepatitis C	-	-	-	-	-	3	26	35	17	13	5	6	3	2	2	5	46	24	22	14
HIV/AIDS*	206	226	237	234	242	311	317	359	423	456	463	441	461	469	454	456	455	408	434	313
Sexually Transmitted Infections	6318	6251	6686	6891	8173	10697	11048	10989	11523	12280	11381	10742	11159	10869	10347	10183	10318	10767	11315	10316
Other Diseases																				
Legionellosis	79	65	52	40	46	17	21	19	16	25	22	25	21	31	24	37	17	12	19	22
Leprosy	22	18	14	11	11	14	13	12	12	10	8	13	16	15	12	6	3	7	6	6
Melioidosis	81	77	59	34	44	98	78	62	61	62	40	60	34	31	36	34	42	58	52	34
Tuberculosis **	1543	1518	1474	1702	1684	1578	1586	1581	1608	1951	1966	2028	2126	2203	2028	2018	2000	2310	2191	2182

* Refers to Singaporeans/PR cases

** Refers to Singaporeans/PR cases & long staying foreigners from year 2002

INFECTIOUS DISEASE NOTIFICATIONS IN SINGAPORE, 1999-2018(cont'd)

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
										Crude Incidence Rate (per 100,000 population)^											
Air/Droplet-Borne Diseases																				
Diphtheria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haemophilus influenzae type b	-	0	0.1	0	0.1	0	0.1	0.1	0	0	0.1	0.1	0	0	0.2	0.1	0.1	0	0.1	0.1
Hand, Foot and Mouth Disease	35.6	158.9	125.4	388.6	136.2	153.9	357.7	347.2	435.9	613.4	346.4	608.2	399.1	698.8	587.9	405.3	509.8	751.8	599.8	713.2
Measles	1.6	3.5	1.5	1.4	0.8	2.3	0.8	0.6	0.3	0.4	0.3	1.0	2.9	0.7	0.9	2.6	0.8	2.4	1.2	0.6
Meningococcal infection	-	-	0.1	0.3	0.3	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0	0.1	0.2	0.1	0.1	0.2	0.2
Mumps	161.3	148.5	33.8	26.1	21.3	24.1	23.5	19.2	17.0	16.6	12.7	8.9	9.7	9.8	9.2	8.7	8.5	9.6	9.3	8.4
Pertussis	-	-	-	-	-	0	0	0.1	0.8	0.7	0.3	0.2	0.6	0.5	0.3	0.4	1.0	1.5	1.4	1.9
Pneumococcal disease (Invasive)	-	-	-	-	-	-	-	-	-	-	3.1	3.3	2.9	3.1	3.1	2.7	2.5	2.3	2.8	2.4
Rubella	10.9	7.7	5.8	3.6	2.1	3.4	3.3	2.0	1.8	3.7	3.6	3.1	2.1	1.2	0.9	0.3	0.3	0.2	0.3	0.2
Varicella	798.0	597.7	440.3	649.5	371.0	482.0	568.4	545.9	511.6	-	-	-	-	-	-	-	-	-	-	-
Vector-Borne Diseases																				
Chikungunya Fever	-	-	-	-	-	-	-	-	-	14.8	6.8	0.5	0.2	0.4	19.6	3.3	0.8	0.6	0.5	0.3
Dengue fever/Dengue haemorrhagic fever	34.2	16.7	57.3	94.5	116.4	227.0	333.1	71.0	192.3	145.3	90.2	105.6	102.8	87.2	410.6	335.0	204.0	233.4	49.3	58.2
Malaria	8.0	6.6	5.5	4.2	2.9	3.6	3.9	4.1	3.4	3.1	3.4	3.7	2.9	2.7	2.1	1.1	0.8	0.6	0.7	0.6
Zika virus infection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.2	1.2	0
Food-Borne Diseases																				
Campylobacteriosis	8.7	5.7	2.5	1.2	3.5	3.1	5.6	5.4	3.7	3.7	5.2	6.3	7.2	8.3	7.4	8.0	7.6	7.9	8.8	7.6
Cholera	0.3	0.2	0.2	0	0	0.3	0	0	0.2	0	0.1	0.1	0.04	0	0	0	0.1	0	0.1	0
Enteric fever																				
Typhoid	1.2	2.0	2.0	1.2	0.8	1.2	1.6	1.4	1.5	1.7	1.4	1.6	1.4	1.6	1.6	1.1	0.9	0.9	1.2	0.8
Paratyphoid	0.4	0.5	0.8	0.6	0.2	0.8	0.6	0.5	0.7	0.6	0.6	0.7	0.6	1.1	0.4	0.3	0.5	0.3	0.3	0.3
Hepatitis A	2.2	1.9	1.4	5.7	1.3	1.6	2.3	3.3	1.9	2.2	1.8	1.3	1.3	2.0	1.6	1.3	0.9	0.9	1.4	1.3
Hepatitis E	0.5	0.4	0.1	0.6	0.4	0.6	0.8	0.7	0.8	1.1	1.8	2.2	1.9	2.0	1.0	1.2	1.1	1.3	1.4	1.0
Salmonellosis	-	2.5	4.8	3.1	4.7	8.3	6.9	8.6	6.7	14.9	22.9	29.2	26.5	28.2	32.1	35.1	35.9	39.4	35.8	28.7
Blood-Borne & Sexually Transmitted Diseases																				
Hepatitis B	3.5	2.9	1.9	1.5	1.6	2.4	1.9	2.2	1.7	1.8	1.4	1.3	1.4	1.1	1.1	0.9	0.9	0.8	0.7	1.0
Hepatitis C	-	-	-	-	-	0.1	0.6	0.8	0.4	0.3	0.1	0.1	0.1	0	0.0	0.1	0.8	0.4	0.4	0.2
HIV/AIDS	6.4	6.9	7.1	6.9	7.2	9.1	9.1	10.1	11.8	12.5	12.4	11.7	12.2	12.3	11.8	11.8	11.7	10.4	10.9	7.8
Sexually Transmitted Infections	159.6	155.2	161.6	165.0	198.6	256.7	259.0	249.7	251.1	253.8	228.2	211.6	215.3	204.6	191.6	186.2	186.4	192.0	201.6	183.0
Other Diseases																				
Legionellosis	2.0	1.6	1.3	1.0	1.1	0.4	0.5	0.4	0.3	0.5	0.4	0.5	0.4	0.6	0.4	0.7	0.3	0.2	0.3	0.4
Leprosy	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.2	0.1	0	0.1	0.1	0.1
Melioidosis	2.0	1.9	1.4	0.8	1.1	2.4	1.8	1.4	1.3	1.3	0.8	1.2	0.7	0.6	0.7	0.6	0.8	1.0	0.9	0.6
Tuberculosis	47.8	46.4	44.3	40.8	40.9	37.9	37.2	35.9	35.0	40.3	39.4	39.9	41.0	41.5	37.6	36.9	36.1	41.2	39.0	38.7

^Total number of notifications / 2018 estimated mid-year population

CHAPTER 2

AIR/DROPLET-BORNE DISEASES

Droplets can be formed when a person coughs, sneezes or talks. Airborne transmission occurs by the dissemination of droplet nuclei which are small particle residues five micrometres or smaller in diameter and can remain suspended in the air for long periods of time. In comparison, droplet transmission occurs when droplets containing microorganisms generated from infected persons are propelled a short distance (within a meter) through air and deposited on the host's mucous membranes such as conjunctiva, nasal mucosa, mouth or respiratory tract.

HAEMOPHILUS INFLUENZAE TYPE B DISEASE

Haemophilus influenzae type b (Hib) is a gram-negative coccobacillus that causes severe illnesses such as pneumonia, bacteraemia and meningitis. The mode of transmission is by inhalation of respiratory droplets or direct contact with respiratory tract secretions of infected persons.

In 2018, there were five cases of Hib disease reported compared to eight cases in 2017 (Figure 2.1). All five cases were laboratory-confirmed with positive blood cultures. Of the five confirmed cases, four were indigenous cases and the remaining one was a foreigner seeking medical treatment (Table 2.1). The age range among the indigenous cases was 29 to 87 years, and there was an equal ratio of females to males (Table 2.2). Among the three major ethnic groups, the Chinese had the highest incidence rate (Table 2.3).

Figure 2.1
Weekly distribution of reported Hib cases, 2017-2018

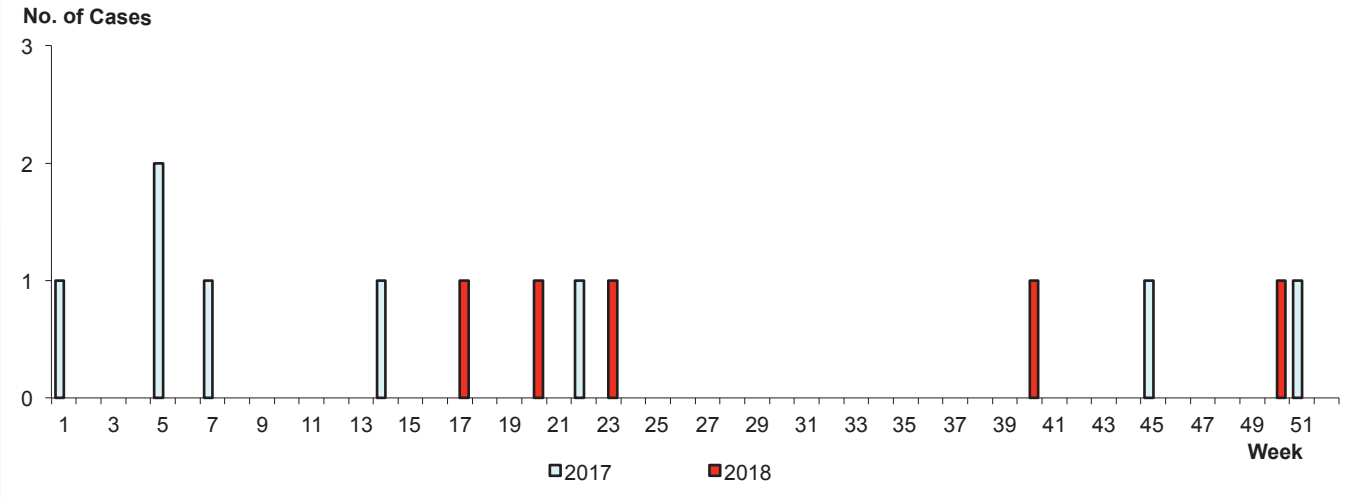


Table 2.1
Age-gender distribution and age-specific incidence rate of reported Hib cases^, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	1	0	0	0	1	0	1	0	0	0
5-14	0	1	0	0	0	0	0	0	0	0
15-24	0	0	0	0	0	0	1	0	0	0
25-34	1	0	0	0	0	0	2	0	1	0
35-44	0	0	0	0	0	0	1	0	1	0
45-54	1	0	0	0	0	0	0	0	0	0
55-64	0	0	0	0	1	0	0	0	1	0
65+	2	0	3	0	0	0	3	0	1	0
Total	**5**	**1**	**3**	**0**	**2**	**0**	**8**	**0**	**4**	**0**

^Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 2.2
Age-gender distribution and age-specific resident incidence rate of reported Hib cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	0	0	0	0	0
25-34	1	0	1	25.0	0
35-44	0	1	1	25.0	0
45-54	0	0	0	0	0
55-64	0	1	1	25.0	0.2
65+	1	0	1	25.0	0.2
Total	**2**	**2**	**4**	**100**	

^Excluded one foreigner seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year resident population.
(Source: Singapore Department of Statistics)

Table 2.3
Ethnic-gender distribution and ethnic-specific incidence rate of reported Hib cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	1	1	2	50.0	0.1
Malay	0	0	0	0	0
Indian	0	0	0	0	0
Others	0	0	0	0	0
Foreigners	1	1	2	50.0	0.1
Total	**2**	**2**	**4**	**100**	**0.1**

^Excluded one foreigner seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

HAND, FOOT AND MOUTH DISEASE

Hand, foot and mouth disease (HFMD) is a common childhood viral disease that is mild and self-limiting. It is characterised by fever, mouth ulcers and rashes on the hands and the feet. The common causative agents for HFMD are the coxsackieviruses, echovirus, and enterovirus A71 (EV-A71). It can be transmitted from person to person through the respiratory or oral-faecal route.

A total of 40,217 cases of HFMD were reported in 2018. This represented an increase of 19.5% compared to the 33,663 cases reported in 2017 (Figure 2.2).

The incidence rate was highest in the 0-4 years age group, with an overall male to female ratio of 1.2:1 (Table 2.4). Among the three major ethnic groups, Malays had the highest incidence rate, followed by Chinese and Indians (Table 2.5).

Viral isolation and polymerase chain reaction (PCR) testing of EV-A71 and other enteroviruses were carried out on samples collected at the KK Women's and Children's Hospital (KKH), National University Hospital and sentinel GP clinics. Of the samples that tested positive for enteroviruses, the majority were coxsackieviruses type A (59.4%), and EV-A71 (13.3%). Among the coxsackieviruses type A, CA10 (44.3%) was the predominant serotype, followed by CA6 (38.6%) and CA16 (14.2%).

Figure 2.2
Weekly distribution of reported HFMD cases, 2017-2018

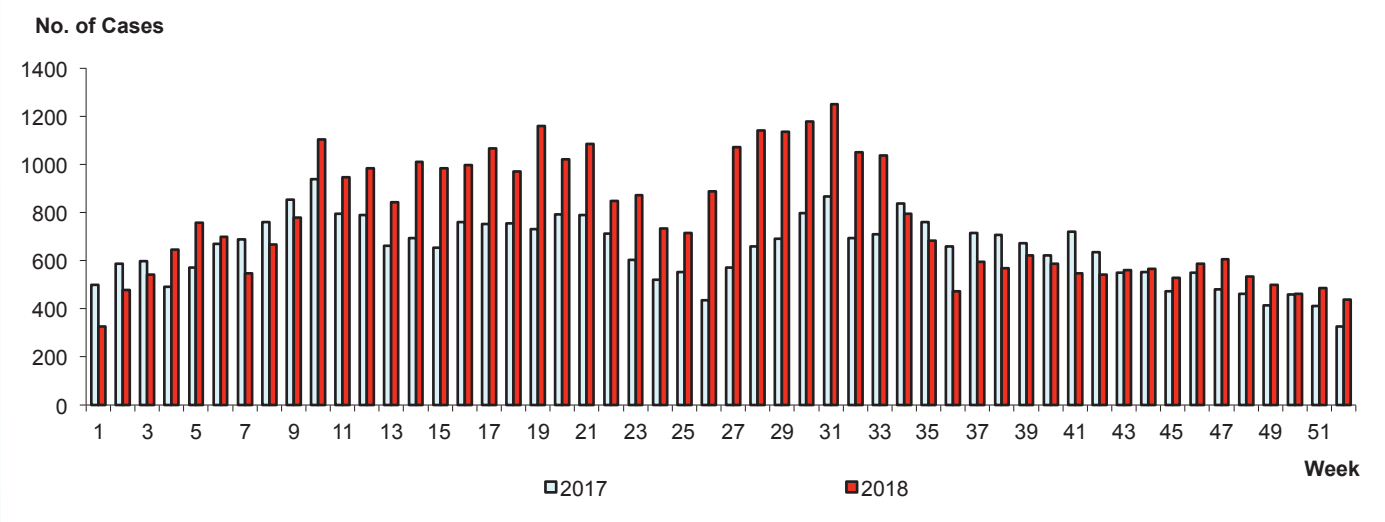


Table 2.4
Age-gender distribution and age-specific resident incidence rate of reported HFMD^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	14,518	12,156	26,674	66.3	14,377.3
5-14	5,098	4,026	9,124	22.7	2,249.5
15-24	660	669	1,329	3.3	275.7
25-34	615	865	1,480	3.7	258.3
35-44	713	550	1,263	3.1	208.1
45-54	125	102	227	0.6	36.8
55+	42	60	102	0.3	9.7
Total	**21,771**	**18,428**	**40,199**	**100**	

^ Excluded 18 tourists in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.5
Ethnic-gender distribution and ethnic-specific incidence rate of reported HFMD^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	14,454	12,358	26,812	66.7	903.0
Malay	3,348	2,876	6,224	15.5	1,161.6
Indian	746	600	1,346	3.3	373.3
Others	1,051	853	1,904	4.7	1,480.0
Foreigners	2,172	1,741	3,913	9.8	238.0
Total	**21,771**	**18,428**	**40,199**	**100**	**712.9**

^ Excluded 18 tourists in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

INFLUENZA

Influenza is an acute viral disease of the respiratory tract characterised by fever, sore throat, cough, coryza, headache and myalgia. It may be complicated by pneumonia, particularly in high risk patients such as those with pre-existing chronic lung disease. It is spread from person to person mainly through infectious respiratory droplets and secretions released during coughing and sneezing.

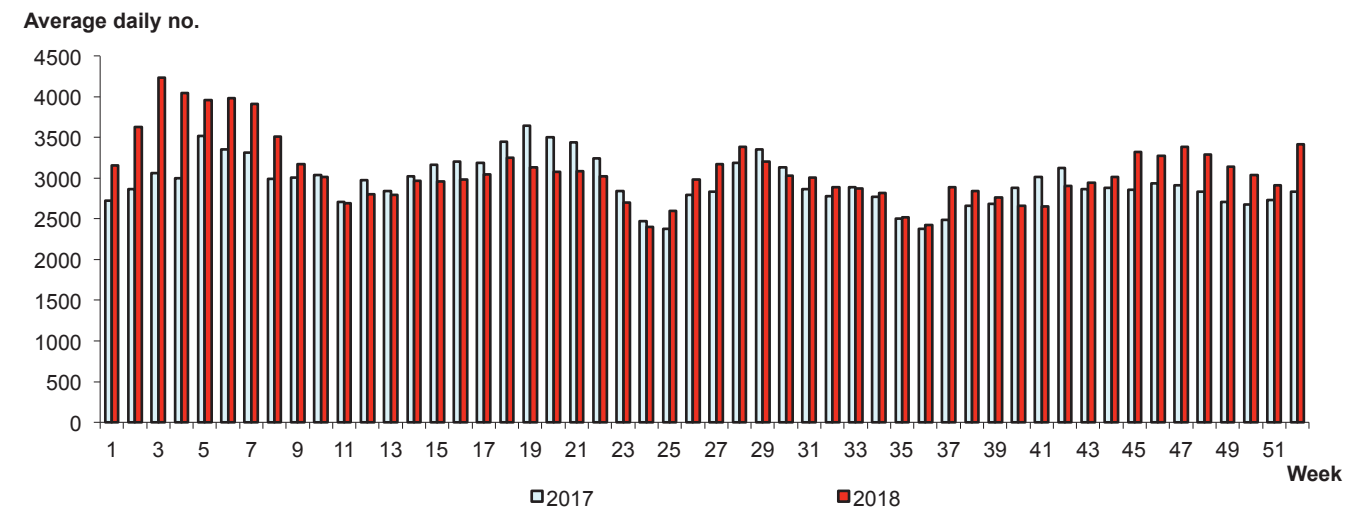
There are three main types – Type A, Type B and Type C. Influenza A(H1N1)pdm09, influenza A(H3N2) and influenza B are influenza viruses commonly circulating globally and in the community. Influenza C is associated with mild sporadic illness and occurs less frequently. Diagnosis is based on the clinical recognition of influenza-like illness with or without laboratory confirmation and strain characterisation.

In temperate and cold climates, influenza reaches peak incidence in winter. In contrast, tropical and subtropical areas may experience influenza epidemics twice a year or even throughout the year. Locally, influenza viruses circulate year-round with a bimodal increase in incidence observed in May–July and November–January.

The weekly attendance for acute respiratory infections (ARI) at polyclinics and public hospitals' emergency departments is routinely monitored as a proxy indicator for influenza activity (Note: ARI represents a mixture of respiratory illnesses and the proportion of influenza cases presenting with ARI varies with the level of influenza activity). The weekly number of admissions due to ARI at public hospitals is also monitored.

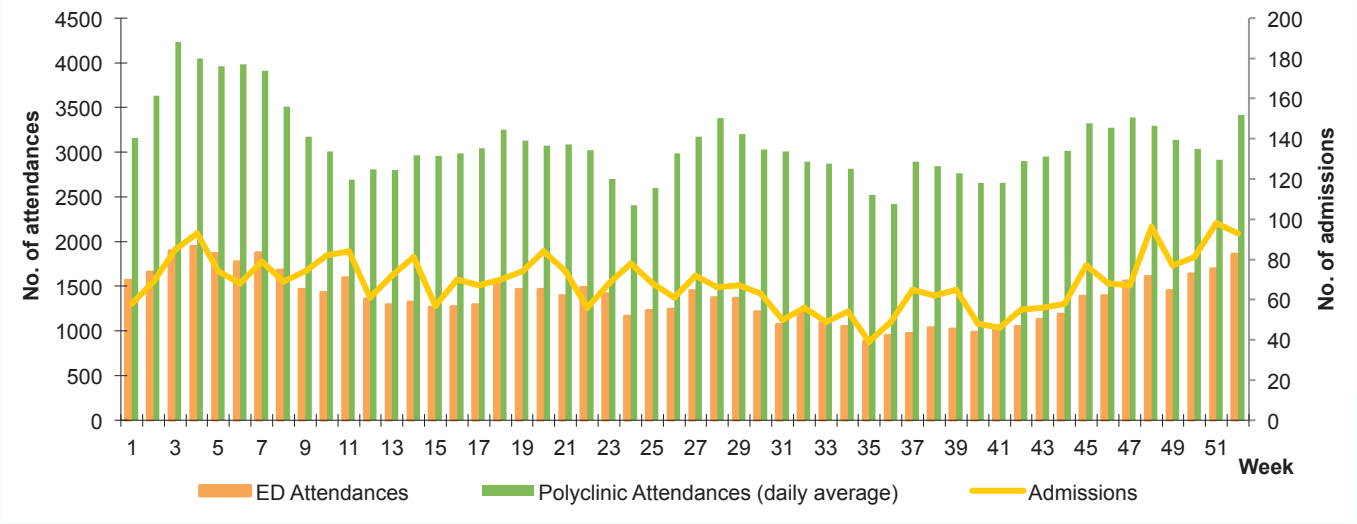
There were a total of 848,444 attendances at polyclinics for ARI in 2018, representing an increase of 4.4% compared to 812,571 seen in 2017. No clear seasonal pattern for ARI was observed (Figure 2.3).

Figure 2.3
Weekly distribution of ARI attendances at polyclinics, 2017-2018



A total of 71,658 ARI cases were seen at the emergency departments (ED) of public hospitals in 2018, a decrease of 12.3% compared to 81,687 cases reported in 2017. Of these 71,658 ARI cases, 3,553 cases were admitted. This is comparable to 3,555 ARI admissions reported in 2017 (Figure 2.4).

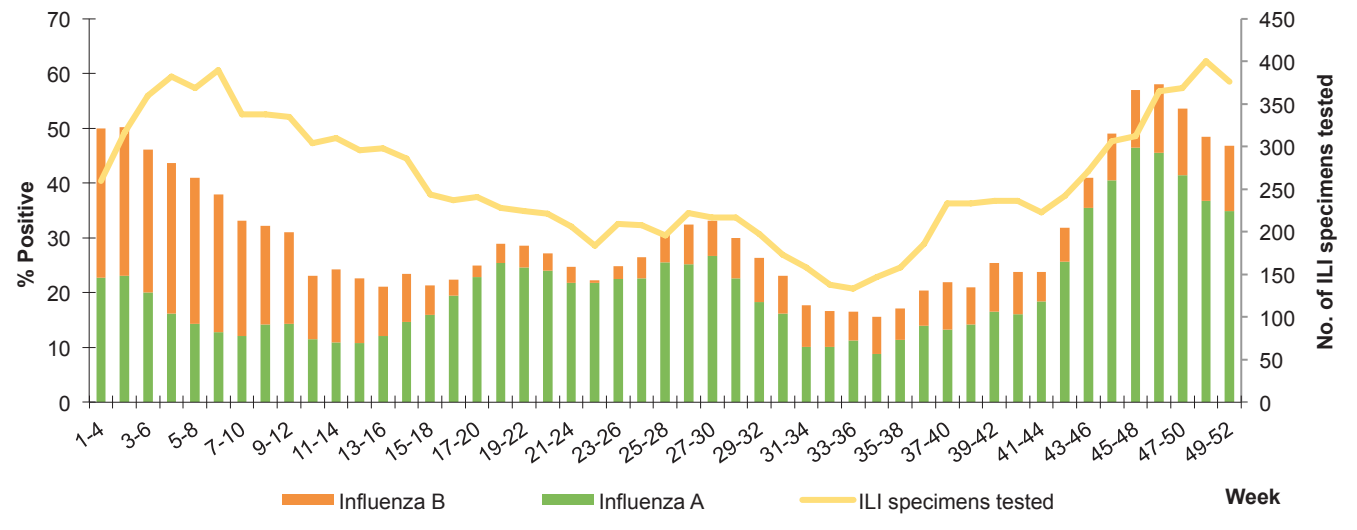
Figure 2.4
Weekly polyclinics attendances, hospitals emergency departments attendances and admissions for acute respiratory infections, 2018



Virological surveillance of influenza viruses is carried out on throat and/or nasopharyngeal specimens obtained from polyclinics, hospitals and sentinel GP clinics throughout the year. The typing, subtyping and isolation of influenza viruses is carried out at the National Public Health Laboratory (NPHL) and at designated hospital laboratories. Further genetic analysis and antigenic characterisation of selected samples is also done by NPHL and the WHO Collaborating Centre for Reference and Research on Influenza in Melbourne, Australia.

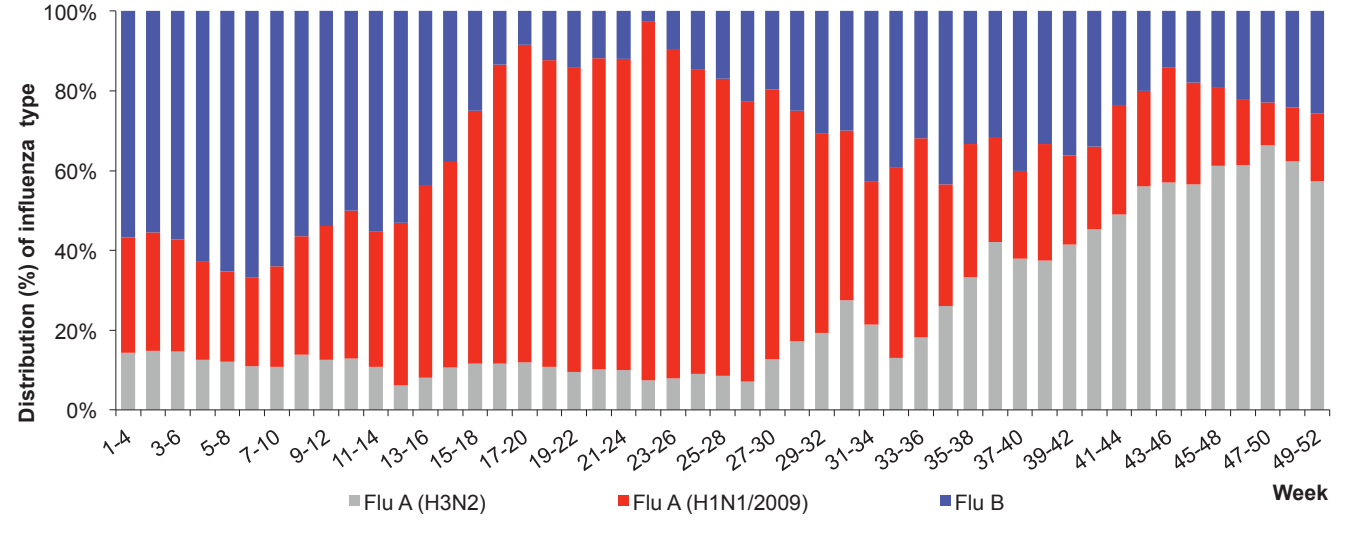
The 4-weekly moving average of the proportion of samples from patients in polyclinics and sentinel GP clinics with influenza-like illness (ILI) which were positive for influenza viruses is shown in Figure 2.5. Higher levels of influenza activity were observed for the 4-weekly moving average between E-weeks 45-48, 46-49 and 47-50, with a range of 53.7% to 58.1%.

Figure 2.5
Virological surveillance of influenza A and B, 2018



In 2018, 34.1% of all ILI samples tested positive for influenza viruses. Of the positive samples, 64.7% tested positive for influenza A viruses, of which 52.5% were of the influenza A(H1N1)pdm09 subtype. Influenza A(H1N1)pdm09, influenza A(H3N2) and influenza B co-circulate in Singapore, with influenza A being the dominant subtype for most of the year (Figure 2.6).

Figure 2.6
Influenza typing results, 2018



In 2018, all influenza A(H1N1)pdm09 viruses analysed by sequencing fell within phylogenetic clade 6B.1 and were antigenically related to the current vaccine strain, A/Michigan/45/2014. Majority of influenza A(H3N2) viruses fell within the major phylogenetic clade 3C.2a, and viruses from subclades 3C.2a1, 3C.2a2 and 3C.2a3 were co-circulating. All viruses evaluated by haemagglutination inhibition remained antigenically related to A/Singapore/INFIMH-16-0019/2016.4 (NH 2018-2019 and SH 2018 vaccine strain). Among the circulating Influenza B viruses, viruses belonging to B/Yamagata/16/88 lineage dominated from January to July and were antigenically similar to B/Phuket/3073/2013 (recommended in quadrivalent vaccine compositions). Thereafter, viruses from B/Victoria/2/87-lineage co-circulated with approximately 70% of sequenced viruses remaining antigenically similar to B/Brisbane/60/2008. The remaining 30% contained a double deletion mutation and belonged to V1A-2DEL clade, represented by the vaccine strain B/Colorado/06/2017 (NH 2018-2019).

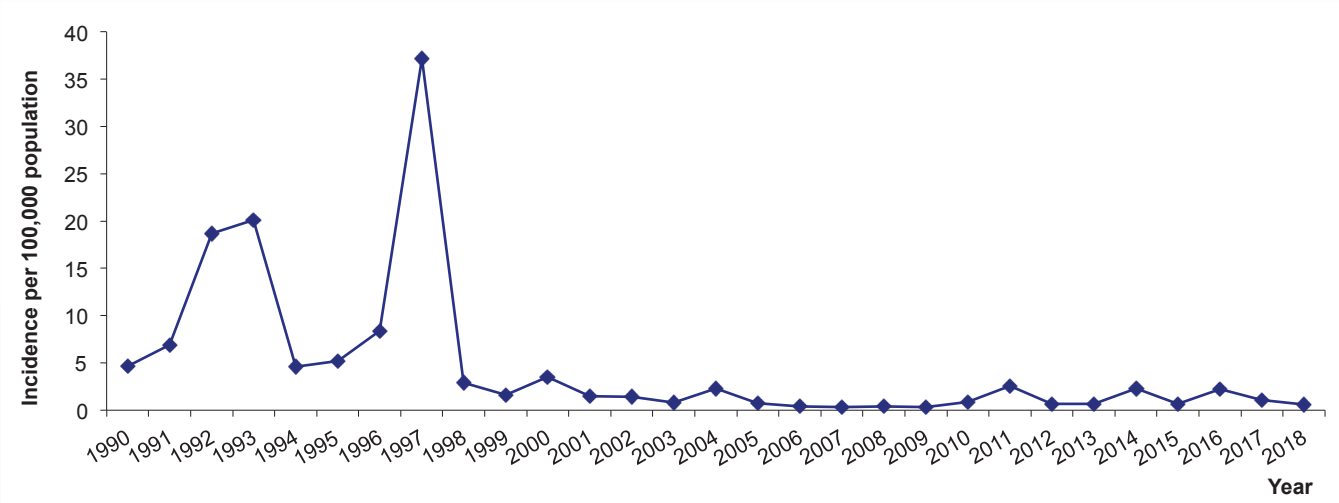
In 2018, more than 400 clinical specimens positive for Influenza A or B viruses were analysed by sequencing. Of which, only 3 isolates of A(H1N1)pdm09 were found to contain the H275Y mutation, which confers resistance to neuraminidase inhibitors.

MEASLES

Measles is an acute, highly communicable viral disease caused by the measles virus, a member of the genus *Morbillivirus* of the family *Paramyxoviridae*. In measles, a maculopapular rash follows shortly after a fever, and is often accompanied by coryza, cough and conjunctivitis. The mode of transmission is airborne by droplet spread, or direct contact with the nasal or throat secretions of an infected person.

In Singapore, the number of reported measles cases has rapidly declined with the introduction of compulsory measles vaccination in August 1985. In 1992 and 1997, there was an increase in the number of reported cases (Figure 2.7). All age groups were affected and as a result, the “catch-up” immunisation initiative was implemented in July-November 1997 and the two-dose MMR vaccination regime was implemented in January 1998. The incidence of measles has remained at a low level since then.

Figure 2.7
Incidence of reported measles cases, 1990-2018



A total of 34 laboratory confirmed cases of measles were reported in 2018 compared to 70 cases reported in 2017 (Figure 2.8). Of the 34 confirmed cases, 26 were indigenous cases, six were imported cases and the remaining two involved tourists in Singapore (Table 2.6). The highest incidence rate was observed in children between six months and less than one year of age (Table 2.7). Among the three major ethnic groups, Malays had the highest incidence rate, followed by Chinese. There were no measles cases involving Indian residents in 2018 (Table 2.8).

Figure 2.8
Weekly distribution of reported measles cases, 2017-2018

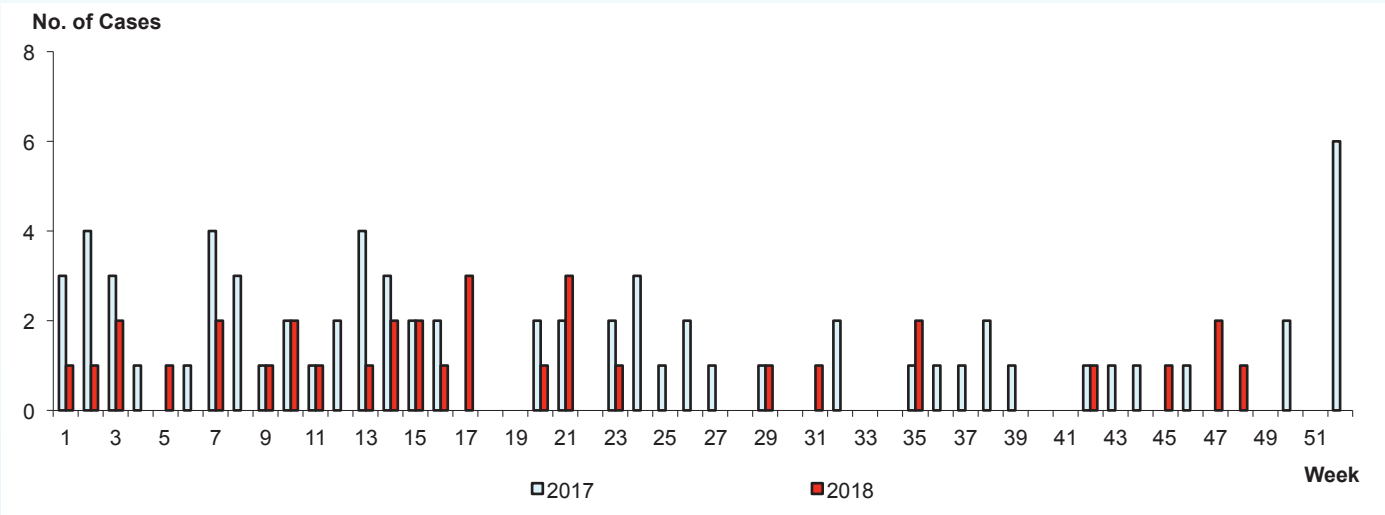


Table 2.6
Total number of notifications* received for measles, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
< 6 mths	4	0	1	0	10	0	1	0	1	1
6 mths-< 1yr	21	7	9	0	33	2	10	0	4	2
1-4	31	9	6	2	27	3	7	1	4	0
5-9	2	0	1	0	11	0	3	0	0	0
10-14	0	0	1	0	0	0	0	0	0	0
15-24	4	2	2	1	1	0	4	1	0	1
25-34	20	8	4	6	16	1	11	1	5	2
35-44	14	1	5	2	17	2	10	5	11	0
45-54	3	2	0	0	3	0	4	0	0	0
55+	0	0	0	0	0	0	1	0	1	0
Total	**99**	**29**	**29**	**11**	**118**	**8**	**51**	**8**	**26**	**6**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 2.7
Age-gender distribution and age-specific resident incidence rate of reported measles cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
< 6 mths	1	1	2	6.3	0
6 mths-< 1yr	2	4	6	18.7	21.6
1-4	1	3	4	12.5	2.7
5-9	0	0	0	0	0
10-14	0	0	0	0	0
15-24	0	1	1	3.1	0.2
25-34	5	2	7	21.9	0.5
35-44	5	6	11	34.4	1.0
45-54	0	0	0	0	0
55+	0	1	1	3.1	0.1
Total	**14**	**18**	**32**	**100**	

^Excluded two tourists in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.8
Ethnic-gender distribution and ethnic-specific incidence rate of reported measles cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	4	9	13	40.6	0.4
Malay	2	2	4	12.5	0.7
Indian	0	0	0	0	0
Others	1	1	2	6.3	1.6
Foreigners	7	6	13	40.6	0.8
Total	**14**	**18**	**32**	**100**	**0.6**

^Excluded two tourists in Singapore
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

MENINGOCOCCAL INFECTION

Meningococcal meningitis is an acute bacterial disease characterised by a sudden onset of fever, intense headache, nausea, vomiting and a stiff neck. It is often accompanied by a petechial rash, and can progress to sepsis and death. The causative agent is *Neisseria meningitidis*, with serotype groups A, B, C, Y, W-135, X and Z accounting for most disease cases. The mode of transmission is via direct contact, including respiratory droplets from nose and throat of infected persons.

In 2018, there were nine cases of meningococcal infection reported compared to twelve cases in 2017 (Table 2.9). All cases were laboratory-confirmed with culture-positive or PCR-positive blood or cerebrospinal fluid. The incidence rate was highest in the 0-4 years age group, and serotype B was implicated in five cases (Tables 2.10 and 2.11).

Table 2.9
Total number of notifications^ received for meningococcal infection, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	3	0	2	0	0	0	1	1	3	0
5-14	0	0	0	0	0	0	0	0	0	0
15-24	0	0	2	0	2	0	4	0	2	0
25-34	1	0	2	0	1	0	1	0	1	0
35-44	1	0	0	0	0	1	1	0	1	0
45-54	2	0	0	0	0	0	0	0	1	0
55-64	2	0	0	0	0	0	2	0	0	0
65+	0	0	0	0	0	1	2	0	0	0
Total	**9**	**0**	**6**	**0**	**3**	**2**	**11**	**1**	**8**	**0**

^Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 2.10
Age-gender distribution and age-specific resident incidence rate of reported meningococcal infection cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	1	2	3	37.5	1.6
5-14	0	0	0	0	0
15-24	2	0	2	25.0	0.4
25-34	0	1	1	12.5	0.2
35-44	1	0	1	12.5	0
45-54	0	1	1	12.5	0.2
55-64	0	0	0	0	0
65+	0	0	0	0	0
Total	**4**	**4**	**8**	**100**	

^Excluded one foreigner seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year resident population.
(Source: Singapore Department of Statistics)

Table 2.11
Epidemiological data of eight reported meningococcal infection cases, 2018

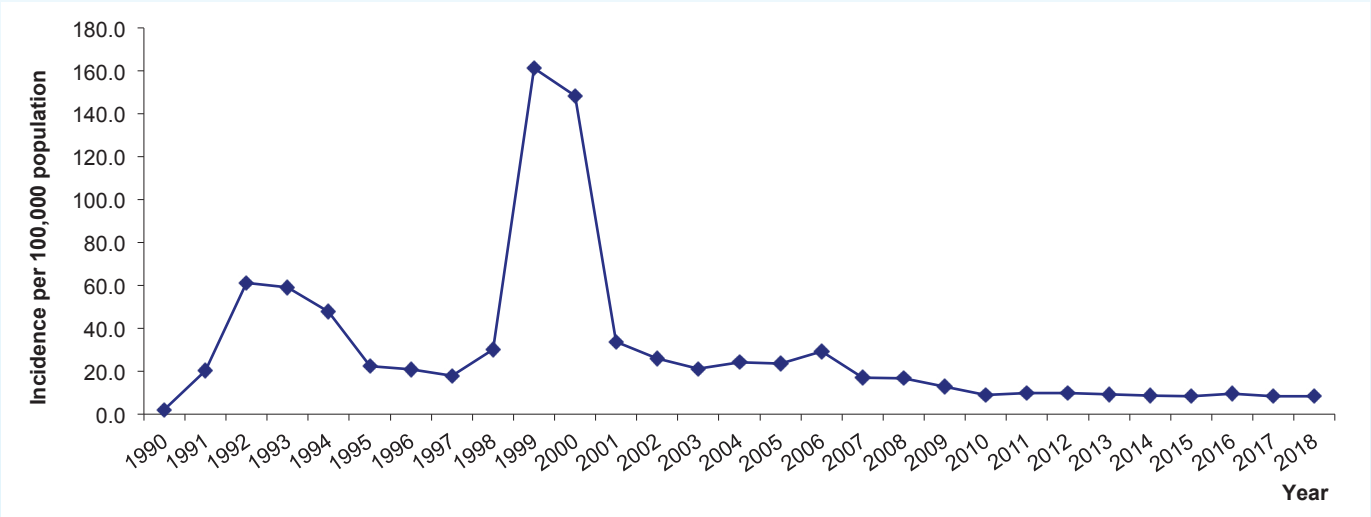
Case particulars				
Gender	**Age**	**Ethnic group**	**Causative agent**	**Status**
F	50 years	Chinese	*Neisseria meningitidis* Grp Y	Recovered
F	8 months	Chinese	*Neisseria meningitidis* Grp B	Recovered
M	19 years	Others	*Neisseria meningitidis* Grp B	Recovered
F	17 months	Indian	*Neisseria meningitidis* Grp B	Recovered
M	4 years	Chinese	*Neisseria meningitidis* Grp B	Recovered
M	18 years	Chinese	*Neisseria meningitidis* Grp Y	Recovered
M	36 years	Sri Lankan	*Neisseria meningitidis* Grp B	Recovered
F	33 years	Malay	*Neisseria meningitidis* (non-groupable)	Recovered

MUMPS

Mumps or infectious parotitis is an acute viral disease characterised by fever, swelling and tenderness of one or more salivary glands. Complications include orchitis, meningitis and deafness. The mumps virus, a member of the family *Paramyxovirus*, is antigenically related to the parainfluenza viruses. The mode of transmission is airborne spread via infected respiratory droplets or by direct contact with the saliva of an infected person.

The incidence of mumps in Singapore increased five-fold between 1998 and 1999, from 1,183 cases to 6,384 cases. Children below 15 years of age were the most affected age group. This increase was due to the low protective efficacy of vaccines containing the Rubini strain, which had been used between the years 1993-1995. Following this resurgence, a more efficacious vaccine replaced the Rubini strain-containing vaccine. Since then, the annual incidence of mumps has declined rapidly and remained low since 2010 (Figure 2.9).

Figure 2.9
Incidence of reported mumps cases, 1990-2018



A total of 474 cases were reported in 2018 as compared to 524 cases in 2017 (Figure 2.10). The incidence rate was highest in the 5-14 years age group (Table 2.12). Among the three major ethnic groups, Chinese had the highest incidence rate, followed by Malays and Indians (Table 2.13).

Figure 2.10
Weekly distribution of reported mumps cases, 2017-2018

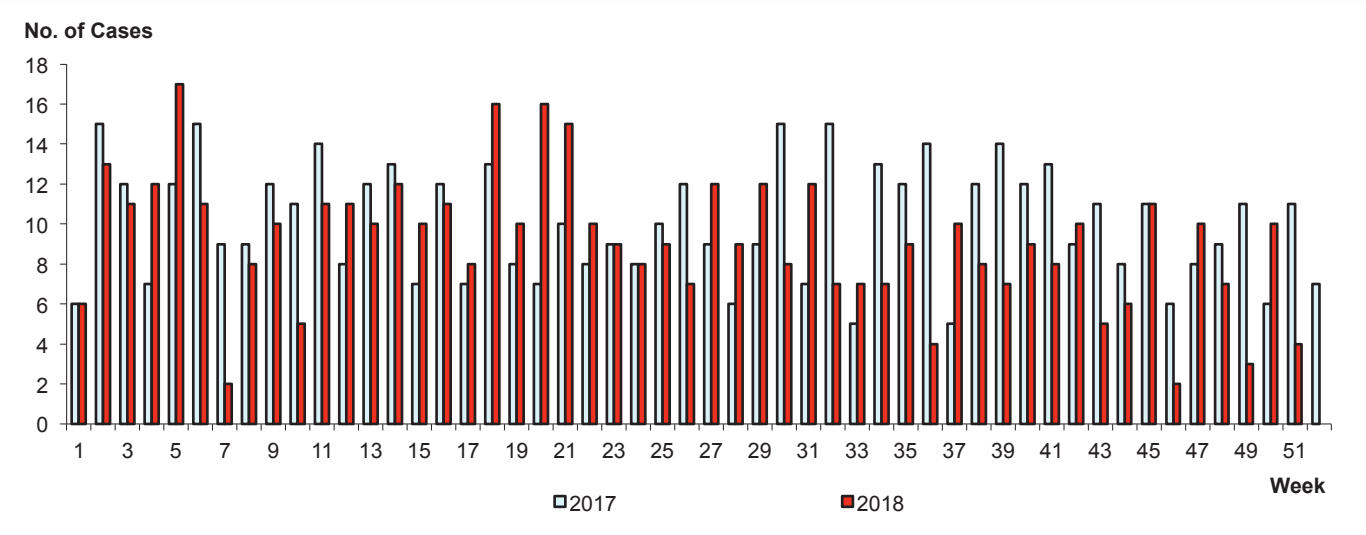


Table 2.12
Age-gender distribution and age-specific resident incidence rate of reported mumps cases, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	31	26	57	12.0	23.2
5-14	92	31	123	26.0	24.9
15-24	21	20	41	8.6	5.2
25-34	49	37	86	18.1	7.5
35-44	39	30	69	14.6	6.6
45-54	22	29	51	10.8	7.3
55-64	10	16	26	5.5	3.8
65+	11	10	21	4.4	3.8
Total	**275**	**199**	**474**	**100**	

*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.13
Ethnic-gender distribution and ethnic-specific incidence rate of reported mumps cases, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	143	117	260	54.8	8.8
Malay	27	19	46	9.7	8.6
Indian	9	6	15	3.2	4.2
Others	14	5	19	4.0	14.8
Foreigners	82	52	134	28.3	8.1
Total	**275**	**199**	**474**	**100**	**8.4**

*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

PERTUSSIS

Pertussis is an acute bacterial infection of the respiratory tract caused by *Bordetella pertussis*. It classically presents with paroxysms of cough and a whooping sound on inspiration. In infants, the infection may be severe with respiratory distress, apnoea and seizures. The mode of transmission is via respiratory droplets or direct contact with the nasal or throat secretions of an infected person.

A total of 108 laboratory confirmed cases of pertussis were reported in 2018 compared to 79 in 2017 (Figure 2.11). Of the 108 confirmed cases, 105 were indigenous cases, one was imported and the remaining two were foreigners seeking medical treatment. (Table 2.14). The highest incidence rate was observed in children below the age of one year (Table 2.15). Among the three major ethnic groups, Malays had the highest incidence rate, followed by Chinese and Indians (Tables 2.16). No pertussis death was reported in 2018.

Figure 2.11
Weekly distribution of reported pertussis cases, 2017-2018

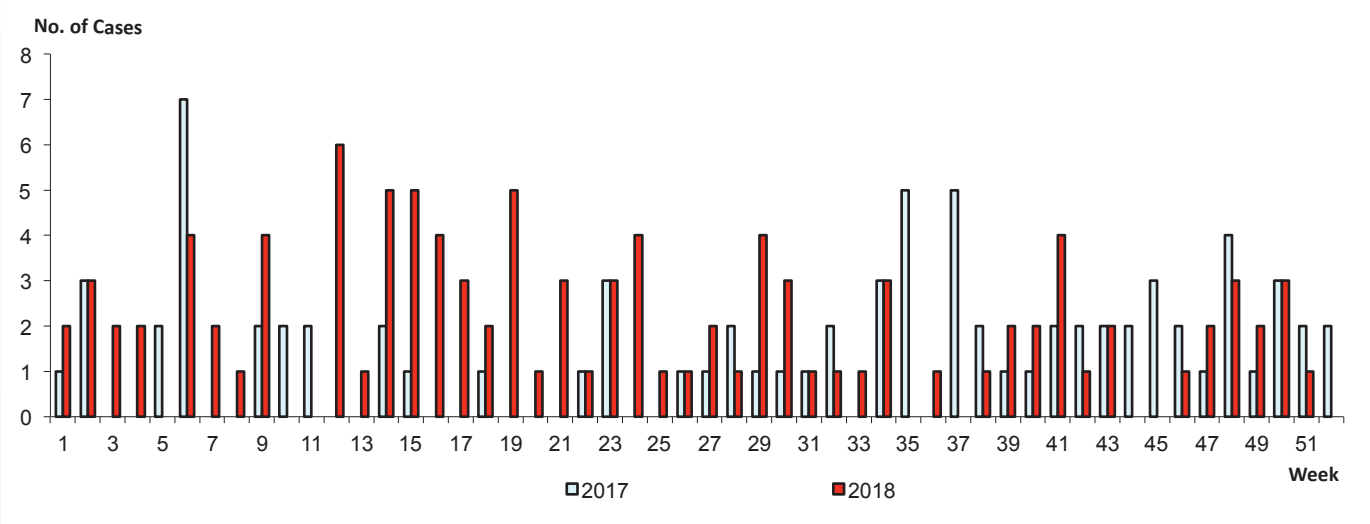


Table 2.14
Total number of notifications* received for pertussis, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	9	2	47	1	44	2	41	0	54	1
5-14	1	0	0	0	7	0	1	0	4	0
15-24	9	0	7	0	21	0	16	0	16	0
25-34	0	0	0	0	1	0	0	0	0	0
35-44	0	0	0	0	0	1	2	0	6	0
45-54	0	0	1	0	2	1	4	0	2	0
55-64	0	0	1	0	2	0	4	0	6	0
65+	0	0	0	0	3	1	8	0	17	0
Total	**19**	**2**	**56**	**1**	**80**	**5**	**76**	**0**	**105**	**1**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 2.15
Age-gender distribution and age-specific resident incidence rate of reported pertussis cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-<1yr	31	17	48	45.3	115.9
1-4	2	5	7	6.6	2.7
5-14	0	4	4	3.8	1.0
15-24	16	0	16	15.1	3.3
25-34	0	0	0	0	0
35-44	3	3	6	5.6	0.7
45-54	2	0	2	1.9	0.3
55-64	2	4	6	5.7	0.9
65+	8	9	17	16.0	3.1
Total	**64**	**42**	**106**	**100**	

^Excluded two foreigners seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.16
Ethnic-gender distribution and ethnic-specific incidence rate of reported pertussis cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	34	16	50	47.2	1.7
Malay	22	14	36	34.0	6.7
Indian	1	5	6	5.6	1.7
Others	2	1	3	2.8	2.3
Foreigners	5	6	11	10.4	0.7
Total	**64**	**42**	**106**	**100**	**1.9**

^ Excluded two foreigners seeking medical treatment in Singapore
*Rates are based on 2018 estimated mid-year population.

PNEUMOCOCCAL DISEASE (INVASIVE)

Invasive pneumococcal disease (IPD) is an acute life-threatening infection of the brain or blood stream caused by the bacteria *Streptococcus pneumoniae*. The mode of transmission is by droplets or close contact with the nasopharyngeal secretions of an infected person.

A total of 134 laboratory confirmed cases of invasive pneumococcal infection were reported in 2018 compared to 156[1] cases reported in 2017 (Figure 2.12). Of the 134 confirmed cases, 127 were indigenous cases, three were imported cases, three were foreigners seeking medical treatment and one was a tourist (Table 2.17). Among residents, the incidence rate was highest in the 65 years and above age group (Table 2.18). Among the three major ethnic groups, Malays had the highest incidence rate, followed by Indians and Chinese (Table 2.19). Of these 134 laboratory confirmed IPD cases, 102 cases were serotyped (76.1%). The predominant pneumococcal type was Type 3 in both children and in adults (Tables 2.20 and 2.21).

[1] Figure revised in 2018. One misclassified case was removed from the reported figure of 157 cases of IPD in the previous year's report.

Figure 2.12
Weekly distribution of reported invasive pneumococcal disease cases, 2017-2018

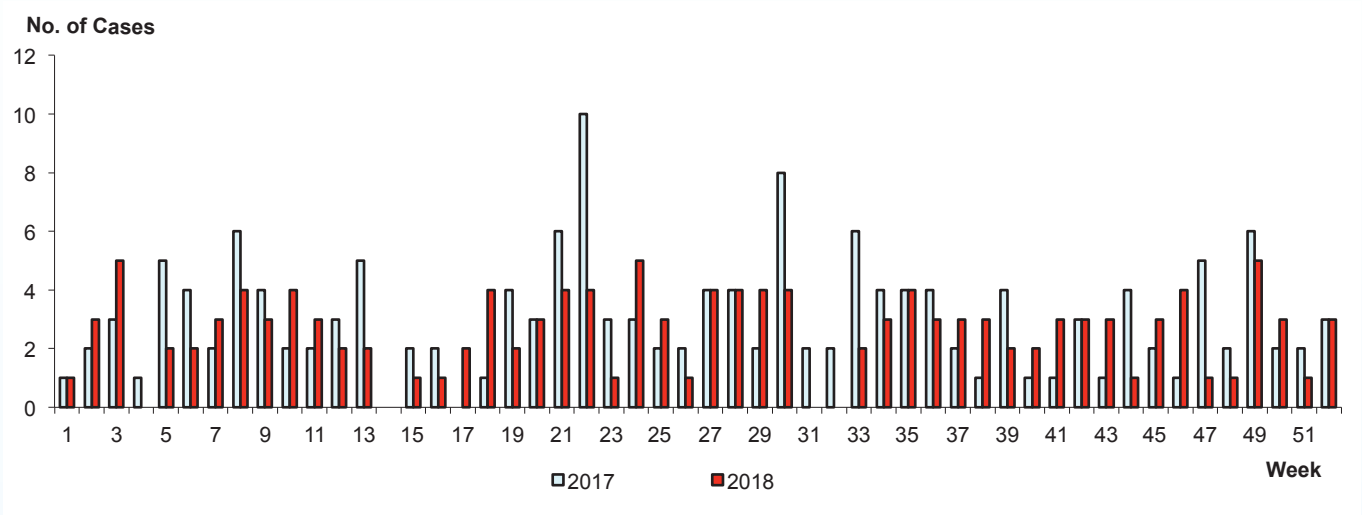


Table 2.17
Total number of notifications* received for invasive pneumococcal disease cases, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	14	0	10	1	7	2	9	0	9	0
5-14	7	1	9	0	10	0	1	0	6	0
15-24	2	1	4	0	2	0	2	0	3	0
25-34	11	0	9	1	10	1	4	0	5	0
35-44	9	1	11	0	13	1	10	0	10	0
45-54	11	1	15	0	12	1	17	2	10	2
55-64	24	3	25	0	30	0	43	1	23	0
65+	62	0	60	1	41	1	63	4	61	1
Total	**140**	**7**	**143**	**3**	**125**	**6**	**149**	**7**	**127**	**3**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 2.18
Age-gender distribution and age-specific resident incidence rate of reported invasive pneumococcal disease cases, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	2	7	9	6.9	4.3
5-14	5	1	6	4.6	1.2
15-24	3	0	3	2.3	0.4
25-34	4	1	5	3.8	0.3
35-44	6	4	10	7.7	1.3
45-54	9	3	12	9.2	1.8
55-64	15	8	23	17.7	3.8
65+	43	19	62	47.7	11.1
Total	**87**	**43**	**130**	**100**	

^Excluded four tourists and foreigners seeking medical treatment in Singapore
*Rates are based on 2018 estimated mid-year resident population.
(Source: Singapore Department of Statistics)

Table 2.19
Ethnic-gender distribution and ethnic-specific incidence rate of reported invasive pneumococcal disease cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	53	22	75	57.7	2.5
Malay	12	15	27	20.8	5.0
Indian	10	1	11	8.5	3.1
Others	3	3	6	4.6	4.7
Foreigners	9	2	11	8.5	0.7
Total	**87**	**43**	**130**	**100**	**2.3**

^Excluded four tourists and foreigners seeking medical treatment in Singapore
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.20
Distribution of pneumococcal serotypes among children cases, 2018

Pneumococcal Type/ Group	Number of isolates (n = 8) (%)
Type 3 §	2 (25.0)
Type 19A §	1 (12.5)
Type 19F §	1 (12.5)
Non-groupable	4 (50.0)

§ Serotype included in PCV13.

Table 2.21
Distribution of pneumococcal serotypes among adult cases, 2018

Pneumococcal Type/ Group	Number of isolates (n = 94) (%)
Type 1 §	0 (0)
Type 3 §	12 (12.8)
Type 4 *§	3 (3.2)
Type 6A §	3 (3.2)
Type 6B *§	2 (2.1)
Type 6C	2 (2.1)
Type 7C	0 (0)
Type 7F §	5 (5.3)
Type 8	1 (1.1)
Type 9V *§	1 (1.1)
Group 9 (not 9N or 9V)	1 (1.1)
Group 10	0 (0)
Group 11	0 (0)
Group 12	5 (5.3)
Type 14 *§	5 (5.3)
Type 15A	5 (5.3)
Type 15B	4 (4.3)
Type 15C	3 (3.2)
Type 15F	0 (0)
Group 17	1 (1.1)
Type 18C *§	1 (1.1)
Group 18 (not 18C and 18F)	1 (1.1)
Type 19A §	9 (9.6)
Type 19F *§	3 (3.2)
Group 20	1 (1.1)
Type 22F	1 (1.1)
Type 23A	7 (7.4)
Type 23B	2 (2.1)
Type 23F *§	5 (5.3)
Group 33	0 (0)
Non-groupable	11 (11.7)

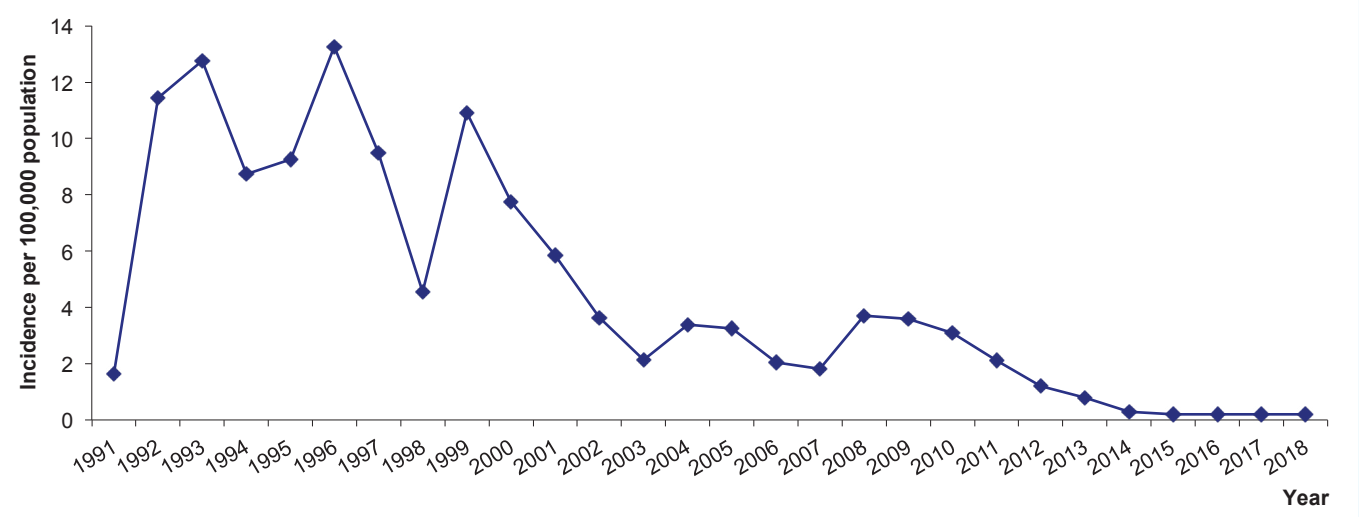
* Serotype included in PCV7
§ Serotype included in PCV13

RUBELLA

Rubella infections, also known as German measles, are usually mild and characterized by febrile illness with a diffuse punctate and maculopapular rash sometimes resembling that of measles or scarlet fever. However, as it is a teratogen, infection in pregnant women can result in fetal death and congenital abnormalities. The causative agent is the rubella virus (genus *Rubivirus*) from the *Togaviridae* family and it is spread through droplets or by close contact with the nasopharyngeal secretions of an infected person.

Rubella incidence fluctuated during 1991-1999. This was followed by a steady decline from 1999 to 2018 (Figure 2.13).

Figure 2.13
Incidence of reported rubella cases, 1991-2018



A total of 10 laboratory confirmed cases of rubella were reported in 2018 compared to 15 cases reported in 2017 (Figure 2.14). Of the 10 laboratory confirmed cases, eight were indigenous cases and two were imported cases (Table 2.22). The incidence rate was highest in the 25-34 years age group (Table 2.23). All four female cases were in the reproductive age group of 15-44. Among the three major ethnic groups, Chinese had the highest incidence rate (Table 2.24). There were no cases of Congenital Rubella Syndrome (CRS) reported to the Ministry of Health in 2018.

Figure 2.14
Weekly distribution of reported rubella cases, 2017-2018

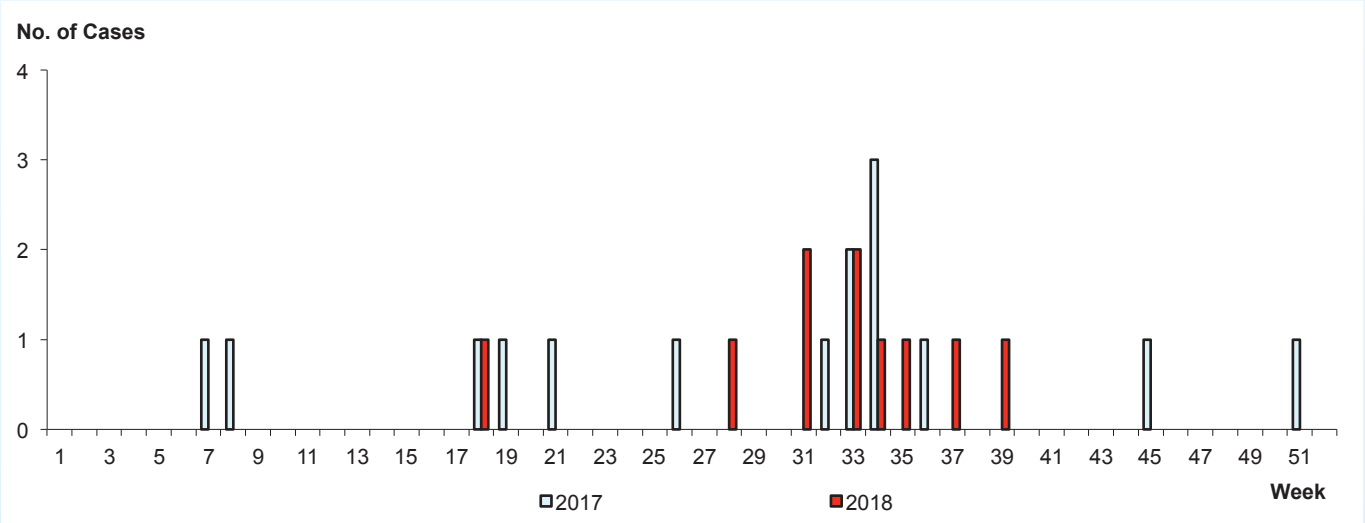


Table 2.22
Total number of notifications* received for rubella, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
< 6 mths	0	0	1	0	2	0	0	0	0	0
6 mths-< 1 yr										
1-4	5	0	3	0	3	0	0	0	0	0
5-9	1	0	1	0	0	0	0	1	0	0
10-14	1	0	0	0	0	0	0	0	0	0
15-24	0	0	1	0	1	0	2	0	2	0
25-34	3	1	4	0	2	1	4	1	4	1
35-44	2	2	3	0	0	1	1	1	0	1
45-54	0	0	0	0	0	0	1	1	2	0
55+	0	0	0	0	0	0	0	0	0	0
Total	**12**	**3**	**13**	**0**	**8**	**2**	**8**	**4**	**8**	**2**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 2.23
Age-gender distribution and age-specific resident incidence rate of reported rubella cases, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	1	1	2	20.0	0.4
25-34	2	3	5	50.0	0.9
35-44	1	0	1	10.0	0.2
45-54	2	0	2	20.0	0.3
55-64	0	0	0	0	0
65+	0	0	0	0	0
Total	**6**	**4**	**10**	**100**	

*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.24
Ethnic-gender distribution and ethnic-specific incidence rate of reported rubella cases, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	2	0	2	20.0	0.1
Malay	0	0	0	0	0
Indian	0	0	0	0	0
Others	0	0	0	0	0
Foreigners	4	4	8	80.0	0.5
Total	**6**	**4**	**10**	**100**	**0.2**

*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

TETANUS

Tetanus is an acute disease caused by *Clostridium tetani* at the site of an injury and is characterized by muscle spasms or hypertonia. The mode of transmission is through introduction of *C. tetani* spores into the body via a wound or breach in the skin.

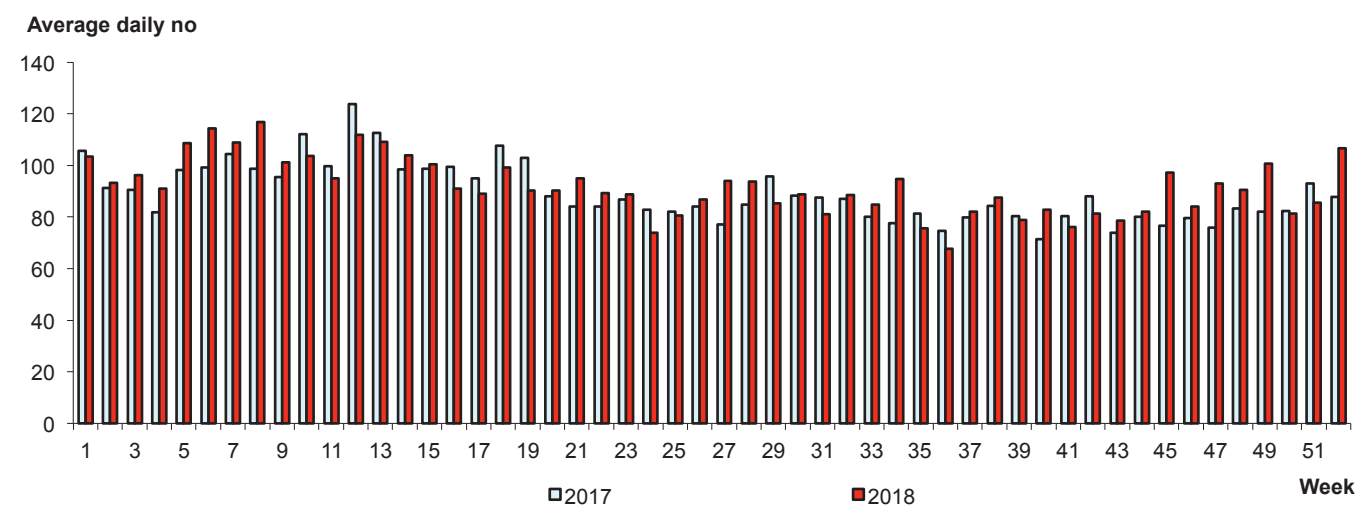
There was one imported case of tetanus reported in 2018 involving a 72-year-old female from Batam, Indonesia. She suffered from a toe laceration in Batam, and subsequently developed swelling at the affected foot and the inability to open mouth and swallow. She was admitted to Changi General Hospital, where she was diagnosed with type 2 respiratory failure with trismus and possible wound tetanus.

CONJUNCTIVITIS

Conjunctivitis is a clinical syndrome characterised by lacrimation, irritation and hyperaemia of the palpebral and bulbar conjunctivae. The common causative agents are the adenoviruses and the enteroviruses.

In 2018, the polyclinics reported 25,134 attendances for conjunctivitis, compared to 24,545 attendances reported in 2017 (Figure 2.15).

Figure 2.15
Weekly distribution of reported conjunctivitis cases, 2017-2018



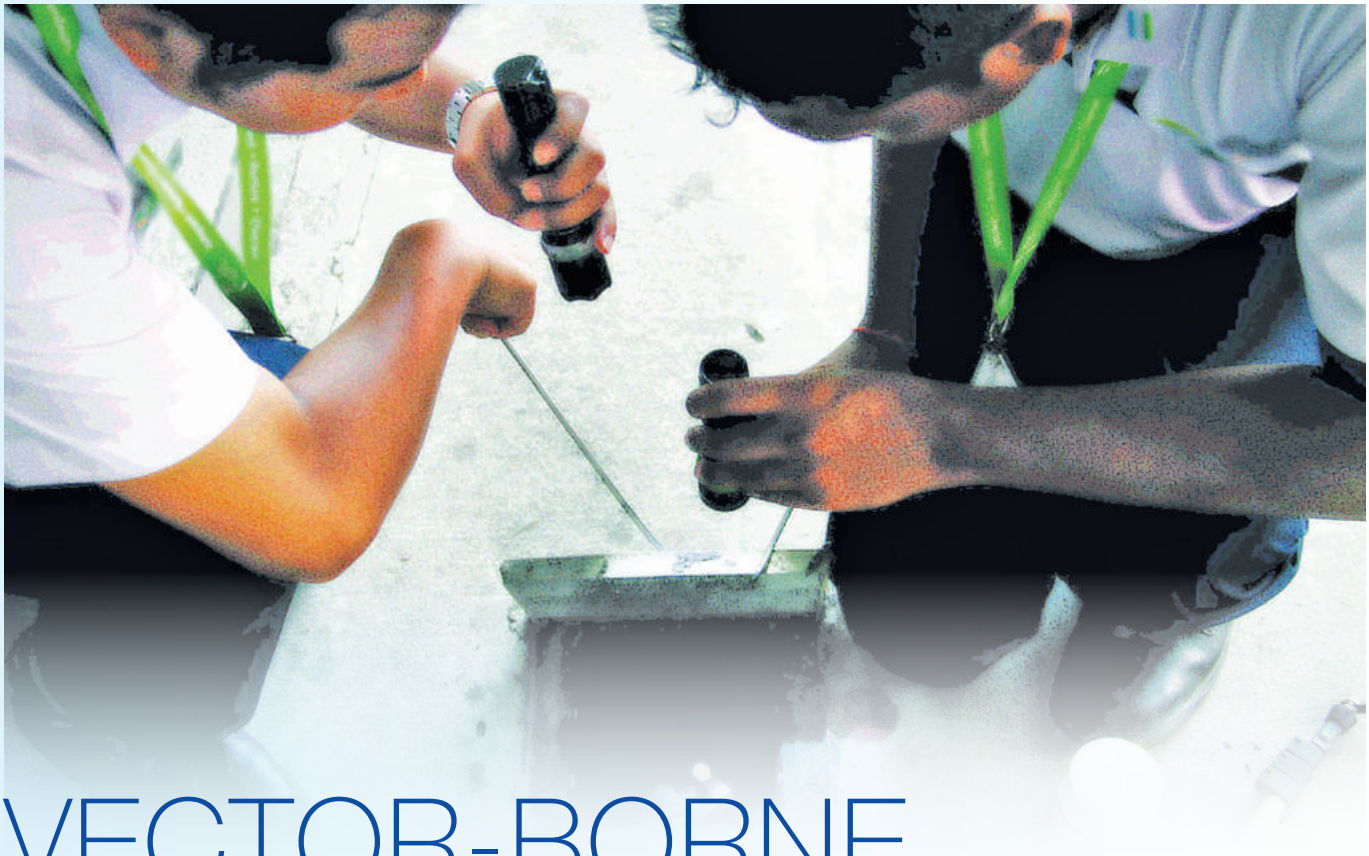
CHICKENPOX

There were a total of 4,337 attendances in polyclinics for chickenpox in 2018 compared to 4,038 attendances in 2017. 91.9% of the attendances were by Singaporeans and Permanent Residents. Persons below the age of 20 years represented 61.8% of attendances for chickenpox (Table 2.25).

Table 2.25
Distribution of varicella (chickenpox) polyclinic attendances by gender, age group and nationality, 2018

Age group	Singaporeans/PRs			Foreigners			Total	%
	Male	Female	Total	Male	Female	Total		
0-9	874	797	1,671	15	8	23	1,694	39.0
10-19	520	455	975	1	12	13	988	22.8
20-29	198	197	395	111	49	160	555	12.8
30-39	147	113	260	92	30	122	382	8.8
40-49	144	82	226	27	4	31	257	5.9
50-59	115	102	217	2	1	3	220	5.1
60+	117	123	240	0	1	1	241	5.6
Total	**2,115**	**1,869**	**3,984**	**248**	**105**	**353**	**4,337**	**100**

CHAPTER 3



VECTOR-BORNE DISEASES

Vectors such as mosquitoes and rodents transmit diseases between humans and from animals to humans. Distribution of these diseases is influenced by a complex dynamic of environmental and social factors, including climate and globalisation.

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 three to 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 15 laboratory confirmed cases of chikungunya fever were reported in 2018, compared to 29 laboratory confirmed cases in 2017 (Figure 3.1). Out of the 15 cases, 12 were imported cases, involving six Singapore residents, five foreigners including work permit/student pass/dependent pass holders and one foreigner seeking medical treatment. The remaining three cases were indigenous cases (Table 3.1). No deaths due to chikungunya were reported in 2018.

Figure 3.1
Weekly distribution of chikungunya fever cases, 2017-2018

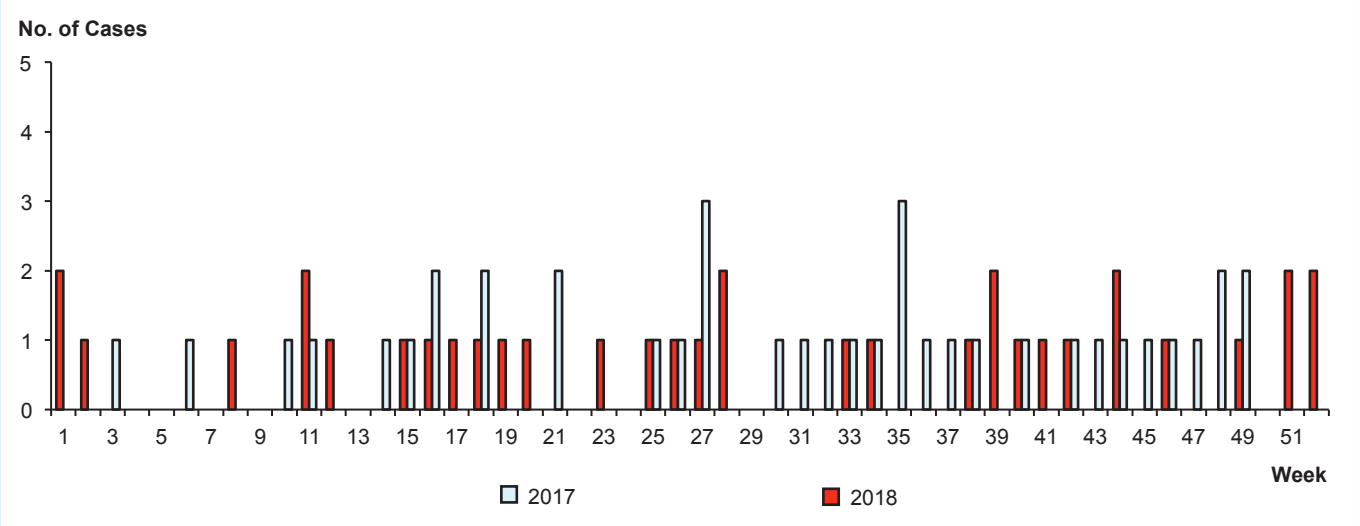


Table 3.1
Total number of notifications* received for chikungunya fever, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	1	0	0	0	0	0	0	0	0	0
5-14	5	0	0	2	1	0	0	1	0	0
15-24	17	0	0	0	0	1	1	1	1	0
25-34	39	3	5	4	0	7	1	4	1	2
35-44	33	4	3	5	0	12	1	2	0	5
45-54	18	5	1	1	0	6	0	5	1	1
55-64	17	1	1	2	1	1	0	3	0	1
65+	9	2	2	0	0	2	0	1	0	2
Total	**139**	**15**	**12**	**14**	**2**	**29**	**3**	**17**	**3**	**11**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Of the three indigenous cases, two were females in the 15-24 and 25-34 age groups, and the remaining was a male in the 45-54 years age group (Table 3.2). Among the three major ethnic groups, Indians had the highest incidence rate, followed by Chinese (Table 3.3).

Table 3.2
Age-gender distribution and age-specific resident incidence rate of indigenous chikungunya fever cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	0	1	1	33.3	0.2
25-34	0	1	1	33.3	0.2
35-44	0	0	0	0	0
45-54	1	0	1	33.3	0.2
55-64	0	0	0	0	0
65+	0	0	0	0	0
Total	**1**	**2**	**3**	**100**	

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 3.3
Ethnic-gender distribution and ethnic-specific incidence rate of indigenous chikungunya fever cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	0	1	1	33.3	0
Malay	0	0	0	0	0
Indian	1	1	2	66.7	0.6
Others	0	0	0	0	0
Foreigners	0	0	0	0	0
Total	**1**	**2**	**3**	**100**	**0.1**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

There were 11 (78.6%) imported cases (excluded one foreigner seeking treatment), defined as residents and non-residents with a history of travel to chikungunya- endemic countries within 12 days prior to the onset of illness. Almost half (45.5%) had history of travel in India (Table 3.4).

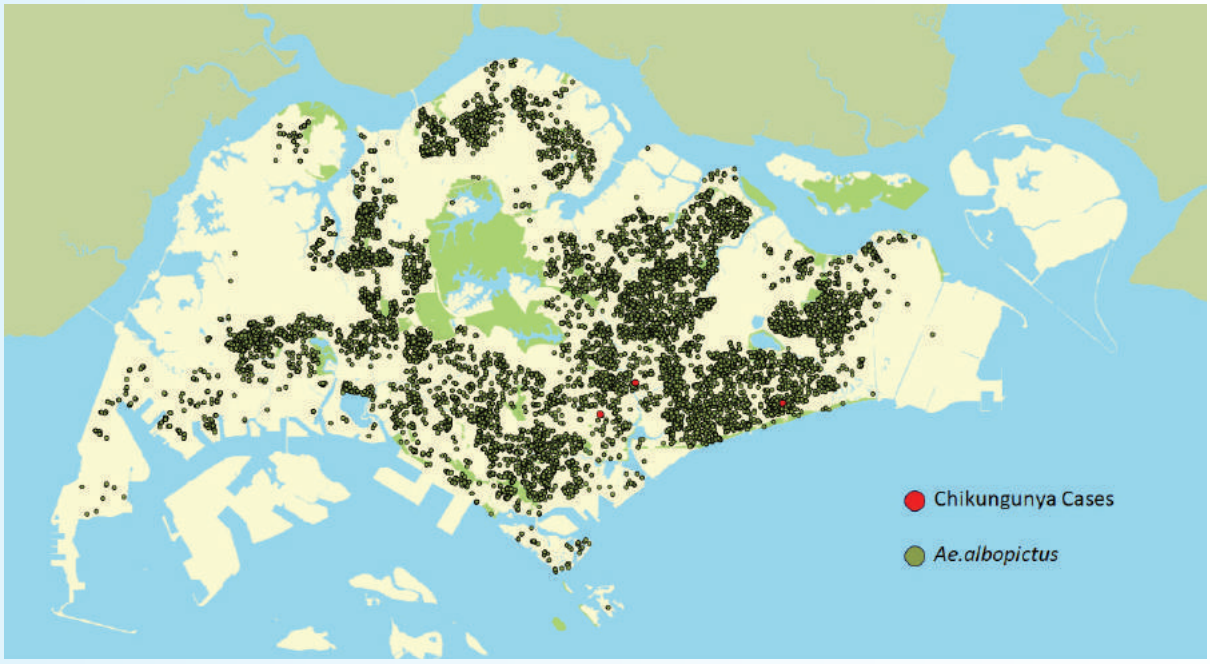
Table 3.4
Imported chikungunya fever cases, 2014-2018

	2014	2015	2016	2017	2018
Southeast Asia					
Thailand	1	0	0	0	2
Myanmar	0	0	1	0	0
Malaysia	1	0	3	3	1
Indonesia	33	9	3	0	0
Philippines	4	0	4	2	2
East Timor	0	3	0	0	0
South Asia					
Bangladesh	0	0	0	11	0
India	1	15	23	9	5
Sri Lanka	0	1	0	0	0
Americas	2	2	0	1	0
Europe	1	0	0	0	0
Total	**43**	**30**	**34**	**26**	**10#**

One case did not provide details of countries visited during the incubation period.

The geographical distribution of indigenous chikungunya fever cases and *Aedes albopictus* is as follows (Figure 3.2).

Figure 3.2
Geographical distribution of indigenous chikungunya fever cases and *Aedes albopictus*, 2018



(Source: National Environment Agency)

DENGUE FEVER/DENGUE HAEMORRHAGIC FEVER

Dengue fever (DF) is an acute febrile viral disease characterised by sudden onset of fever for two to seven days, severe headache with retro-orbital pain, joint and muscle pain, skin rashes, nausea, vomiting and bleeding from nose or gums or easy bruising of skin. The infectious agents are flaviviruses comprising four serotypes (DEN-1, DEN-2, DEN-3 and DEN-4) and are transmitted by the *Aedes* mosquito. In some cases, dengue haemorrhagic fever (DHF), a potentially fatal complication characterised by high fever, thrombocytopenia, haemorrhagic manifestations, and evidence of plasma leakage, may develop.

Dengue cases increased in 2018 as compared to 2017 (Figure 3.3). A total of 3,283 laboratory confirmed cases of dengue (comprising 3,257 cases of DF and 26 cases of DHF) were reported in 2018, an increase of 18.6% from the 2,767 cases reported in 2017. Out of the 3,283 cases, 215 were imported cases involving 58 Singapore residents and 41 foreigners including work permit/student pass/dependent pass holders and 116 tourists or foreigners seeking medical treatment in Singapore. The remaining 3,068 cases were classified as indigenous cases (Table 3.5).

Figure 3.3
Weekly distribution of DF/DHF cases, 2017-2018

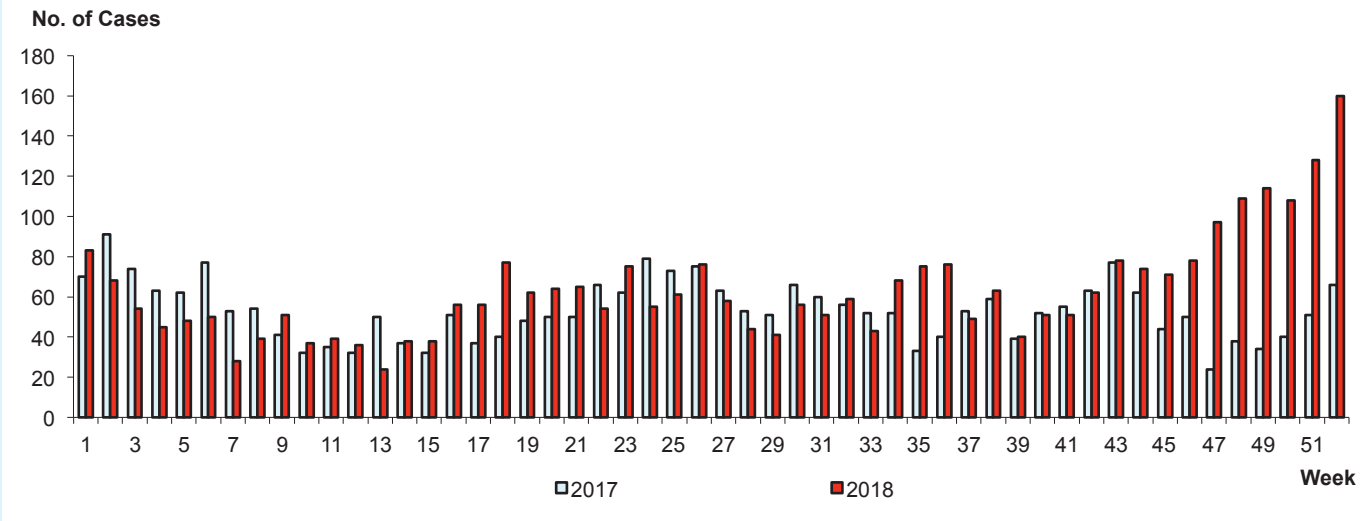


Table 3.5
Total number of notifications* received for DF/DHF cases, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	181	4	96	4	113	1	27	1	44	3
5-14	1,165	18	625	15	760	4	123	5	166	1
15-24	3,169	46	1,792	39	2,046	7	313	17	419	18
25-34	4,971	106	2,916	93	3,338	18	620	32	684	23
35-44	3,789	83	2,184	72	2,651	14	459	27	557	24
45-54	2,384	46	1,508	37	1,864	7	352	17	464	21
55-64	1,256	23	1,012	20	1,176	4	296	11	367	6
65+	897	13	723	11	900	2	328	11	367	3
Total	**17,812**	**339**	**10,856**	**291**	**12,848**	**57**	**2,518**	**121**	**3,068**	**99**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

The resident incidence rate among indigenous cases was highest in the 45-54 age group, with an overall male to female ratio of 1.4:1 (Table 3.6). The incidence was similar among the three major ethnic groups (Table 3.7).

Table 3.6
Age-gender distribution and age-specific resident incidence rate of indigenous DF/DHF cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	28	16	44	1.4	21.0
5-14	94	72	166	5.4	37.2
15-24	268	151	419	13.7	64.5
25-34	410	274	684	22.3	64.4
35-44	323	234	557	18.1	60.8
45-54	257	207	464	15.1	64.9
55-64	200	167	367	12.0	56.8
65+	187	180	367	12.0	63.5
Total	**1,767**	**1,301**	**3,068**	**100**	

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 3.7
Ethnic-gender distribution and ethnic-specific incidence rate of indigenous DF/DHF cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	920	747	1,667	54.3	56.1
Malay	174	120	294	9.6	54.9
Indian	53	96	149	4.9	41.3
Others	103	101	204	6.6	158.6
Foreigners	474	280	754	24.6	45.9
Total	**1,724**	**1,344**	**3,068**	**100**	**54.4**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

There were 215 (6.5%) imported cases with a history of travel to dengue endemic countries within seven days prior to the onset of illness. The majority of these cases (66%) were from Southeast Asian countries: 42 from Indonesia, 31 from Malaysia, 29 from Thailand, 19 from Cambodia, 11 from Philippines, five from Myanmar and five from Viet Nam. The remaining were from South Asia and other regions (Table 3.8).

Table 3.8
Imported DF/DHF cases, 2014-2018

	Year				
	2014	**2015**	**2016**	**2017**	**2018**
Southeast Asia					
Brunei	1	0	1	0	0
Cambodia	1	1	3	4	19
East Timor	5	0	0	1	0
Indonesia	143	116	99	43	42
Laos	1	0	0	1	0
Malaysia	214	191	33	49	31
Myanmar	8	9	2	17	5
Philippines	17	26	12	22	11
Thailand	27	21	10	11	29
Viet Nam	8	7	7	10	5
South Asia					
Bangladesh	6	6	5	6	15
India	39	35	10	61	30
Maldives	6	3	1	2	3
Nepal	1	0	0	0	0
Pakistan	0	1	0	1	2
Sri Lanka	6	2	2	11	5
East Asia					
China	9	2	0	1	1
Other Regions	22	18	10	9	17
Total	**514**	**438**	**195**	**249**	**215**

Residents from Housing and Development Board (HDB) flats, landed properties (including shop houses), condominiums constituted 71.4%, 13.9%, 14.2% of the cases, respectively. The incidence rate of residents from landed properties houses (129.3 per 100,000) was 2.5 times more than that of residents from HDB flats (52.5 per 100,000) (Table 3.9).

Table 3.9
Incidence rate of reported indigenous DF/DHF cases by housing type for Singapore residents, 2018

Housing Type	No.	%	Incidence rate per 100,000 population*
HDB Flats	1,653	71.4	52.5
Landed Properties (including shop houses)	321	13.9	129.3
Condominiums	329	14.2	58.5
Others	11	0.5	31.8
Total	**2,314**	**100**	**54.4**

*Rates are based on 2018 estimated mid-year of population.
(Source: Singapore Department of Statistics)

A total of 243 clusters involving 1,524 epidemiologically linked cases were identified in 2018, of which 29 clusters (11.9%) had 10 or more cases (Table 3.10). Areas with more than 50 cases are listed in Table 3.11. The median number of cases was three and the median duration of transmission was 10 days (Table 3.11).

Table 3.10
Dengue clusters identified, 2014-2018

Year	No. of indigenous cases	No. of clusters*	No. of cases in cluster area (% of indigenous cases)	No. of clusters with ≥10 cases (% of total clusters)	Median no. of cases per cluster	Median duration of transmission (days)
2014	17,812	1,418	9,474 (53.2)	137 (9.7)	3	9
2015	10,856	1,114	5,744 (52.9)	108 (9.7)	3	10
2016	12,890	1,432	6,875 (53.3)	104 (7.3)	3	8
2017	2,518	197	770 (30.4)	11 (5.6)	2	10
2018	3,068	243	1,524 (49.7)	29 (11.9)	3	10

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

Table 3.11
Dengue clusters identified, 2018 (50 or more cases)

S/No.	Locality	No. of cases	Month
1	Bedok Reservoir Rd (Blk 122, 124, 125, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 144, 145, 146, 147, 148, 149, 150, 151, 608, 609, 613, 613A, 613B, 615, 616, 619, 621, 622, 623, 624, 626, 627, 628, 629, 631, 632) / Jln Damai (Blk 670) / Jln Tenaga (Blk 654) / Kaki Bt Ave 1	206	Nov
2	Jurong West St 91 (Blk 933, 934, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 952) / Jurong West St 92 (Blk 920, 922, 925, 928) / Jurong West St 93 (Blk 966) / Yunnan Cres	92	Apr
3	Bedok Nth Ave 1 (Blk 549) / Bedok Nth St 3 (Blk 533, 534, 535, 536, 537, 539, 540, 541, 544, 547, 556, 557)	64	Mar
4	Eastwood Dr, Green, Pl, Rd, Ter, Walk, Way / Eastwood Rd (Eastwood Ctr) / Jln Greja / Pesari Walk / Taman Bedok	63	Nov
5	Canberra Dr (1 Canberra, Eight Courtyards) / Yishun Ave 7 / Yishun Ave 7 (Blk 170, 171, 172, 173, 174) / Yishun Ring Rd (Blk 120, 165, 166)	55	Jul

Dengue deaths

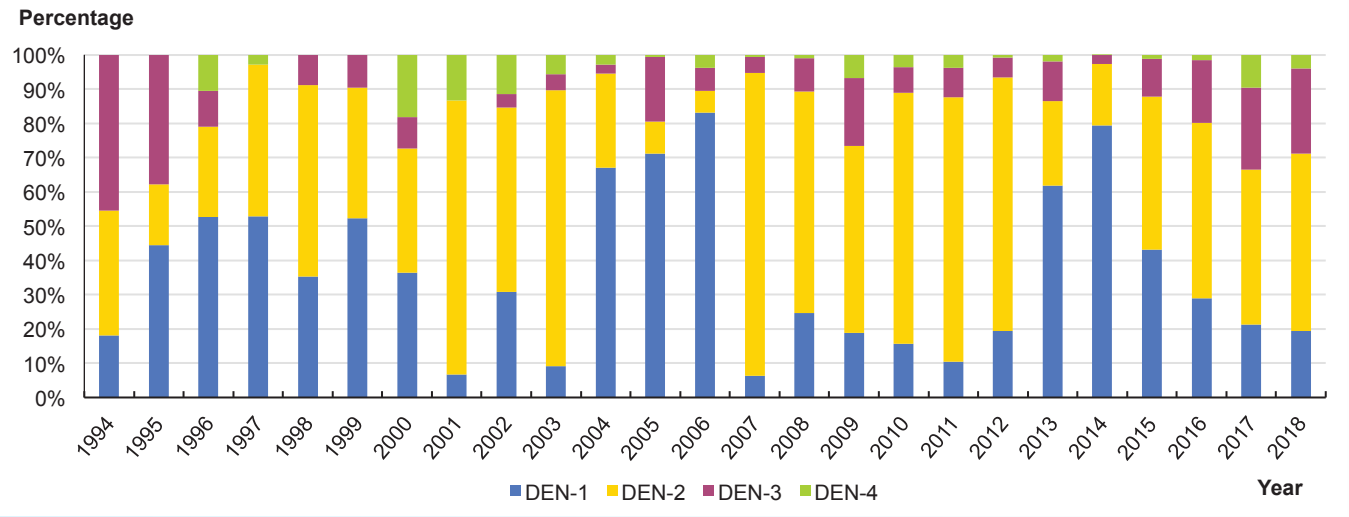
A total of six fatal cases were reported in 2018. Five were classified as indigenous cases while the remaining case was classified as an imported case. Three of the five indigenous cases were residing in an active dengue cluster. The imported case involved a Singapore resident who was in Malaysia before his symptom onset.

Laboratory surveillance

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

A total of 1,229 blood samples obtained from both inpatients and outpatients tested positive for dengue virus by PCR. DEN-2 was the predominant circulating serotype since 2016 (Figure 3.4).

Figure 3.4
Percentages of dengue virus serotypes, 1994-2018



Aedes mosquito vectors surveillance and control

Suppressing the *Aedes* mosquito vector population is the key to dengue control. The National Environment Agency (NEA) adopts an evidence-based integrated approach for the surveillance and control of *Aedes* vectors comprising of surveillance, control, community engagement, enforcement and research.

Surveillance is built on the current regime of inspecting premises and conducting ground surveys 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. This is complemented by adult mosquito surveillance using Gravitraps, which capture female mosquitoes. The Gravitrap surveillance system monitors the *Aedes* mosquito population in HDB housing estates around Singapore. Data collected from the Gravitrap surveillance system helps to provide insights on mosquito population and distribution, and informs operational deployment.

Source reduction is central to Singapore's *Aedes* mosquito 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 operation to systematically search and destroy 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 June and October.

To control the vector population in dengue clusters, NEA carries out search and destroy of mosquito breeding sources complemented by space spraying of insecticides to kill adult mosquitoes. Gravitraps are also used to monitor the extent of control efforts and direct officers to search and destroy at locations with higher *Aedes* mosquito populations.

NEA's Environmental Health Institute (EHI) has studied various novel mosquito control methods since 2010, and has assessed the *Wolbachia* suppression technology to be the most suitable for augmenting Singapore's dengue control programme. *Wolbachia* is a naturally occurring bacterium found in more than 60% of insects, including *Aedes albopictus* mosquitoes but not in *Aedes aegypti* mosquitoes. The strategy involves the release of male *Wolbachia*-carrying *Aedes aegypti* mosquitoes. When these mosquitoes mate with urban *Aedes aegypti* female without *Wolbachia*, their resulting eggs do not hatch as such mating are biologically incompatible. Thus, the continual release of male *Wolbachia*-carrying *Aedes aegypti* is expected to lead to a decline in the *Aedes aegypti* population over time. The strategy is species-specific i.e. release of male *Wolbachia*-carrying *Aedes aegypti* will only impact the *Aedes aegypti* population in the field, and no other insect.

NEA is adopting a systematic phased approach with field trials, to allow for the building of invaluable knowledge for deployment of the technology, especially in a tropical, urbanised, high-rise landscape. Phase 1 field study was conducted from October 2016 to December 2017 at three selected study sites at Braddell Heights, Tampines West and

Nee Soon East to understand the behaviour in our local urban environment. The Phase 1 field study demonstrated that the released male *Wolbachia*-carrying *Aedes aegypti* mosquitoes had successfully competed with the urban *Aedes aegypti* males and mated with some of the urban *Aedes aegypti* females. As a result, the releases led to a 50% suppression of the urban *Aedes aegypti* mosquito population at the study sites. The study also surfaced ecological challenges posed by Singapore's high-density and high-rise housing. Impact of the releases was found to be limited by the movement of *Aedes aegypti* mosquitoes from the surrounding areas into the release sites; as well as by the high *Aedes aegypti* mosquito densities at high floors of some blocks where insufficient numbers of male *Wolbachia*-carrying *Aedes aegypti* mosquitoes reached.

To mitigate high-density and high-rise challenges, the Phase 2 field study was conducted from April 2018 to January 2019 at Tampines West and Nee Soon East study sites, and their extended areas, to further improve the release methodologies to distribute the male *Wolbachia*-carrying *Aedes aegypti* mosquitoes to where they are needed. The release of male *Wolbachia*-carrying *Aedes aegypti* mosquitoes from high floors at residential blocks, in addition to releases at the ground floor, has enabled a better distribution of the male *Wolbachia*-carrying *Aedes aegypti* mosquitoes at Singapore's high-rise residential blocks. Releases at adjoining buffer zones also helped in reducing the infiltration of urban *Aedes aegypti* mosquitoes into the release sites. The release strategy led to about 70 to 80% suppression of the dengue-transmitting *Aedes aegypti* mosquito population at Tampines West and Nee Soon East study sites, respectively, an improvement from the 50% reduction observed in Phase 1.

Project *Wolbachia* – Singapore progressed to Phase 3 field study in February 2019, with an expansion of the Tampines West and Nee Soon East study sites, to determine if the suppression of mosquito populations can be sustained in larger areas. In the long-term, this will require strategies which reduce the number of male *Wolbachia*-carrying *Aedes aegypti* mosquitoes being released in an area.

In 2018, NEA inspected about one million premises. These included residential premises, construction sites, schools, dormitories, factories and other premises types. The geographical distribution of dengue cases, *Aedes aegypti* and *Aedes albopictus* mosquito breeding habitats are shown in Figures 3.5, 3.6 and 3.7 respectively. The overall *Aedes* House Index (HI) was 0.96%, with landed houses showing the highest HI among the residential premises (Figure 3.8).

The top five breeding habitats for *Aedes aegypti* were domestic containers (32.0%), flower pot plates/trays (11.1%), ornamental containers (9.3%), closed perimeter drains (3.7%) and scupper drains of housing estates (2.0%) (Figure 3.9). As for *Aedes albopictus*, the most common breeding habitats were domestic containers (10.6%), flower pot plates/trays (9.8%), discarded receptacles (8.7%), closed perimeter drains (7.7%) and ornamental containers (4.4%) (Figure 3.10).

Figure 3.5
Geographical distribution of dengue cases, 2018

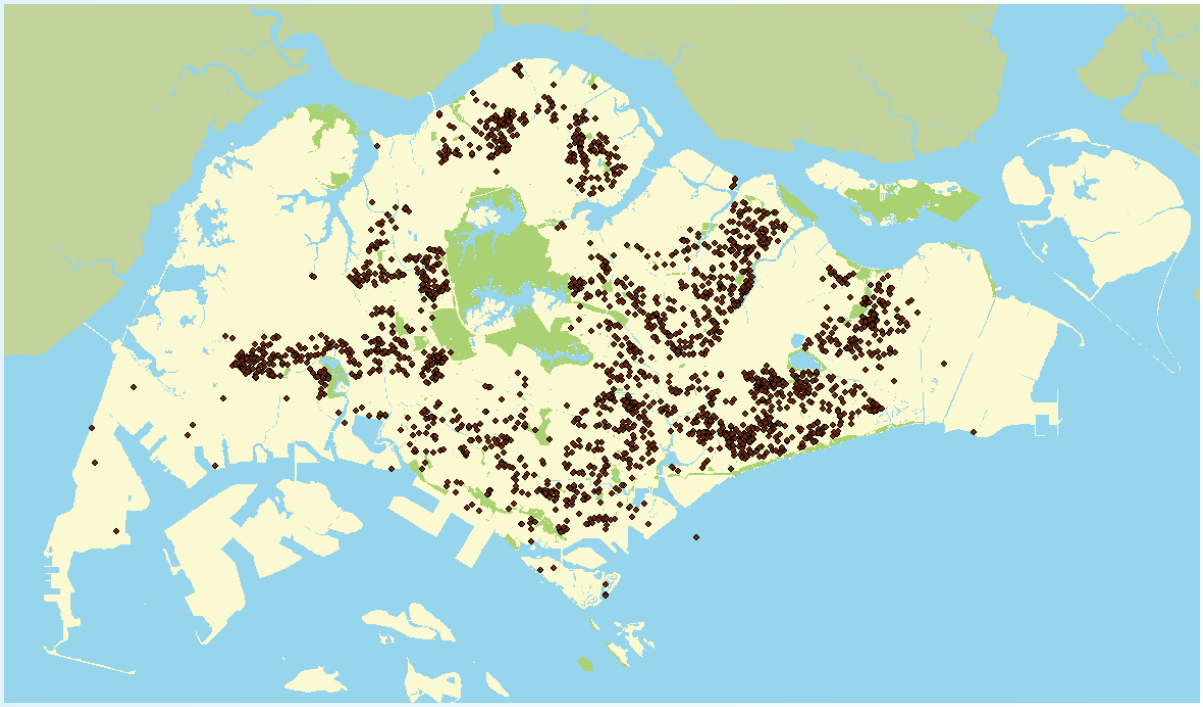


Figure 3.6
Geographical distribution of *Aedes aegypti* breeding habitats detected, 2018

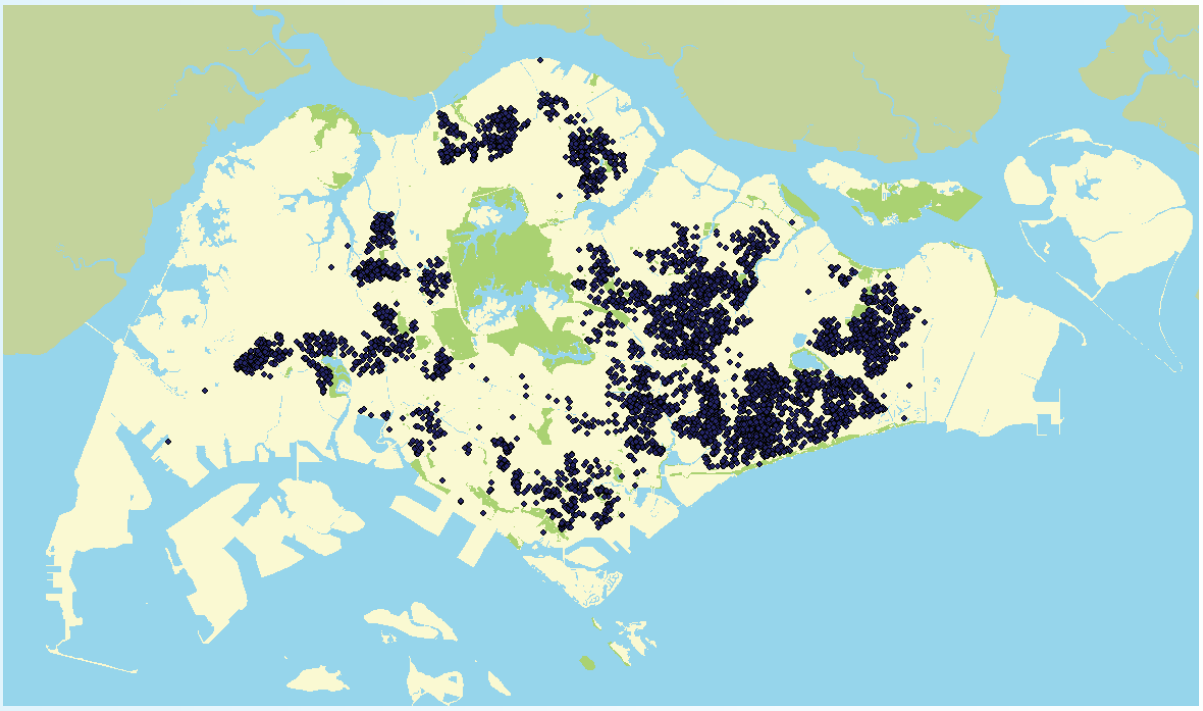


Figure 3.7
Geographical distribution of *Aedes albopictus* breeding habitats detected, 2018

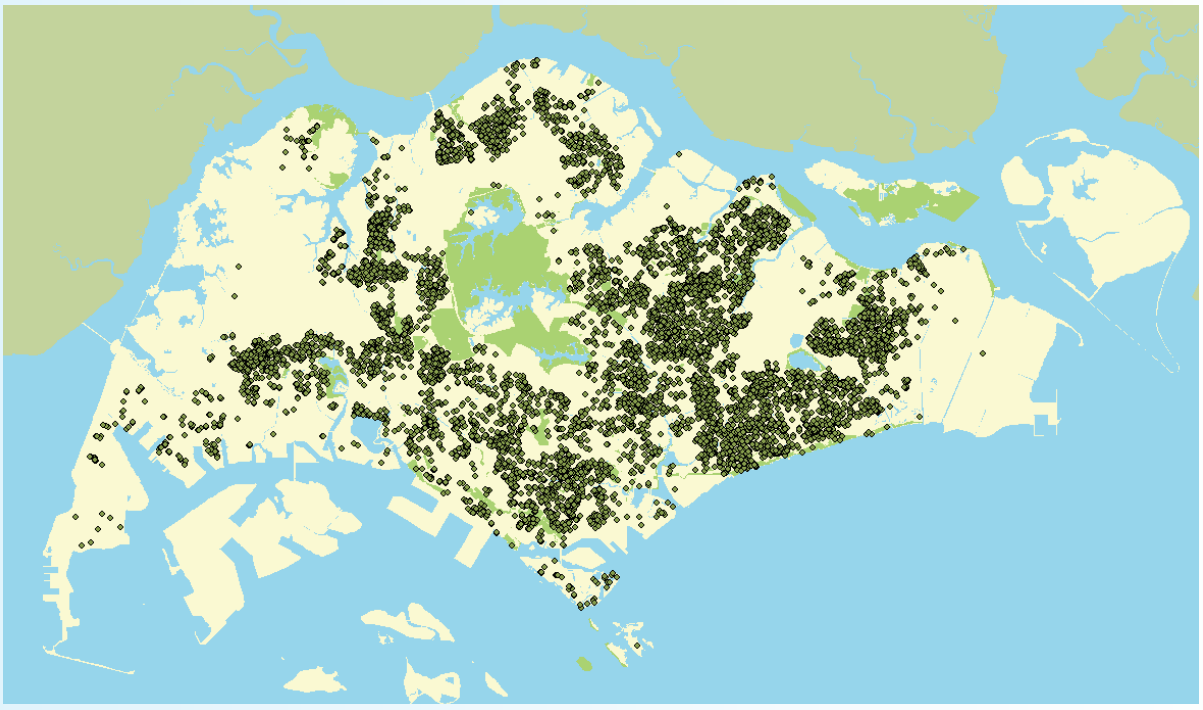


Figure 3.8
***Aedes* House Index, 2014-2018**

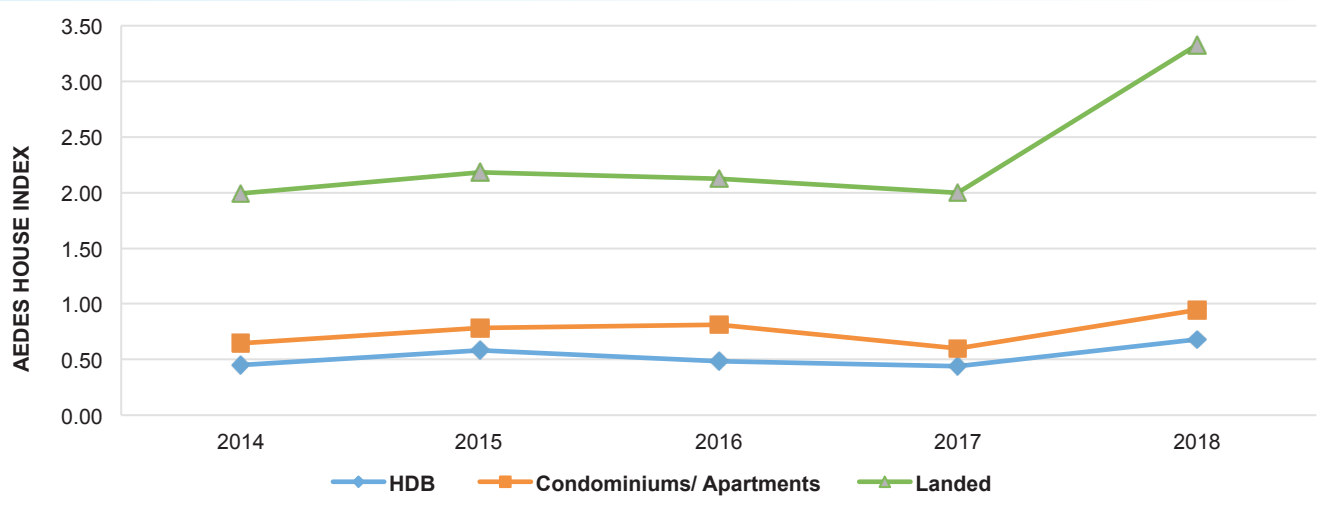


Figure 3.9
Distribution of *Aedes aegypti* top five breeding habitats, 2018

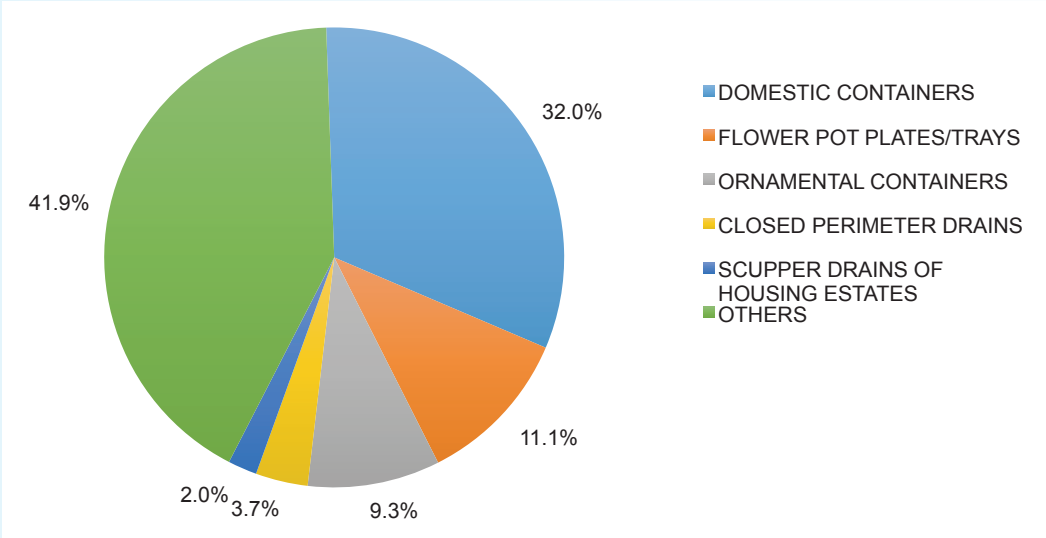
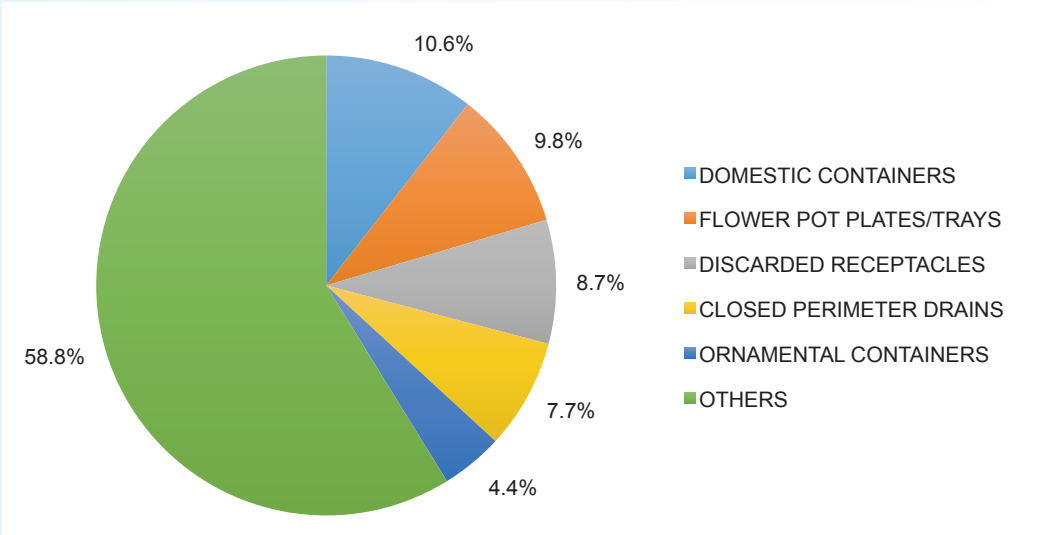


Figure 3.10
Distribution of *Aedes albopictus* top five breeding habitats, 2018



Of the 243 clusters notified in 2018, the two largest clusters were located at Bedok Reservoir Rd / Jln Damai / Jln Tenaga / Kaki Bt Ave 1 and Jurong West St 91 / Jurong West St 92 / Jurong West St 93 / Yunnan Cres.

Cluster at Bedok Reservoir Rd (Blk122, 124, 125, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 144, 145, 146, 147, 148, 149, 150, 151, 608, 609, 613, 613A, 613B, 615, 616, 619, 621, 622, 623, 624, 626, 627, 628, 629, 631, 632) / Jln Damai (Blk 670) / Jln Tenaga (Blk 654) / Kaki Bt Ave 1

On 28 October 2018, the Ministry of Health (MOH) was notified of a dengue case residing at block 136 Bedok Reservoir Road. Another case was reported on 19 November 2018 at block 142 Bedok Reservoir Road. When the cases were notified, vector control operations and epidemiological investigations were carried out. A total of 206 cases were reported in the cluster. The cases had symptoms onset between 22 October 2018 and 15 March 2019. Of the cases serotyped, 106 cases had DEN-2 and two cases had DEN-1. The epidemic curve is shown in Figure 3.11.

166 of the 206 cases (80.6%) were Singapore residents. Majority of the cases were in the 21-60 years' age group (77.2%). The male to female ratio was 1:1.1. The 206 cases included 9 students, 8 housewives, 4 unemployed persons, 2 visitors, 1 retiree and 82 working adults. [Note that 100 (48.5%) cases were not tagged with occupation.] Figure 3.12 shows the geographical distribution of cases in the cluster.

128 mosquito breeding habitats were detected and destroyed. The common breeding habitats found in residential premises included domestic containers (e.g. pail, plastic containers etc.), ornamental containers (e.g. vases, porcelain container) and flower pot / plate/ tray. The common breeding habitats outdoors included closed car park drain. 86 (67.2%) of the breeding habitats were detected in residential premises, 28 (21.9%) in outdoor common areas, 3 (2.3%) at construction sites (road works), 10 (7.8%) in industrial premises and 1 (0.8%) at a place of worship. *Aedes aegypti* accounted for 98 (76.6%) of the breeding habitats, 8 (6.3%) were *Aedes albopictus*, 2 (1.5%) were mixed *Aedes aegypti* and *Aedes albopictus* and the rest were *Culex* mosquitoes. Eight profuse breeding habitats with 100 or more larvae each were detected in discarded items, dish trays, domestic containers and drains.

Figure 3.11
Time distribution of 206 dengue cases at Bedok Reservoir Rd (Blk 122, 124,125, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 144, 145, 146, 147, 148, 149, 150, 151, 608, 609, 613, 613A, 613B, 615, 616, 619, 621, 622, 623, 624, 626, 627, 628, 629, 631, 632) / Jln Damai (Blk 670) / Jln Tenaga (Blk 654) / Kaki Bt Ave 1 cluster

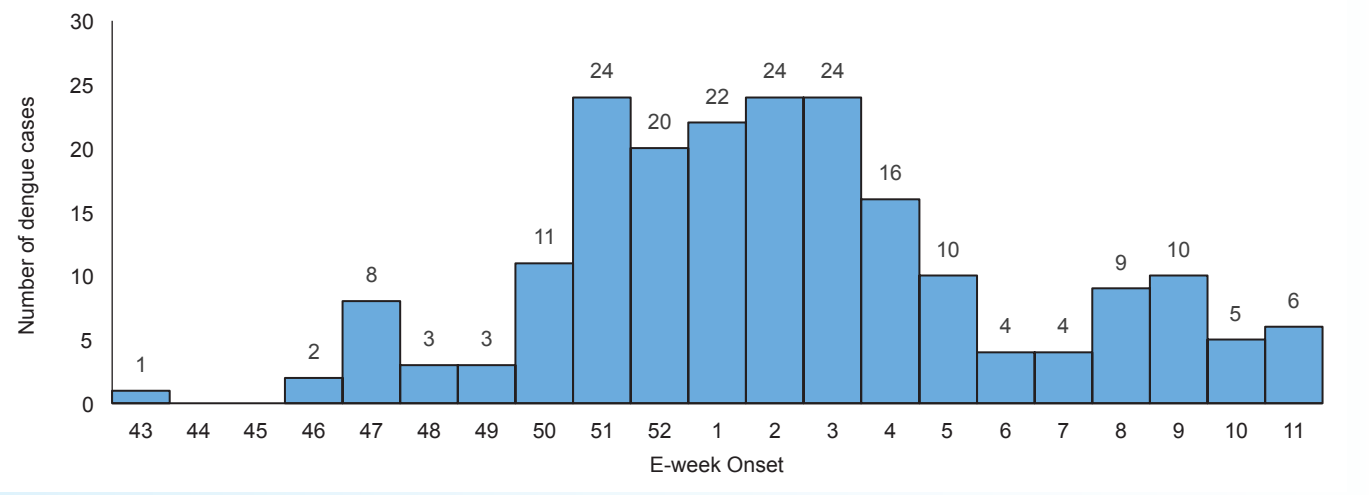
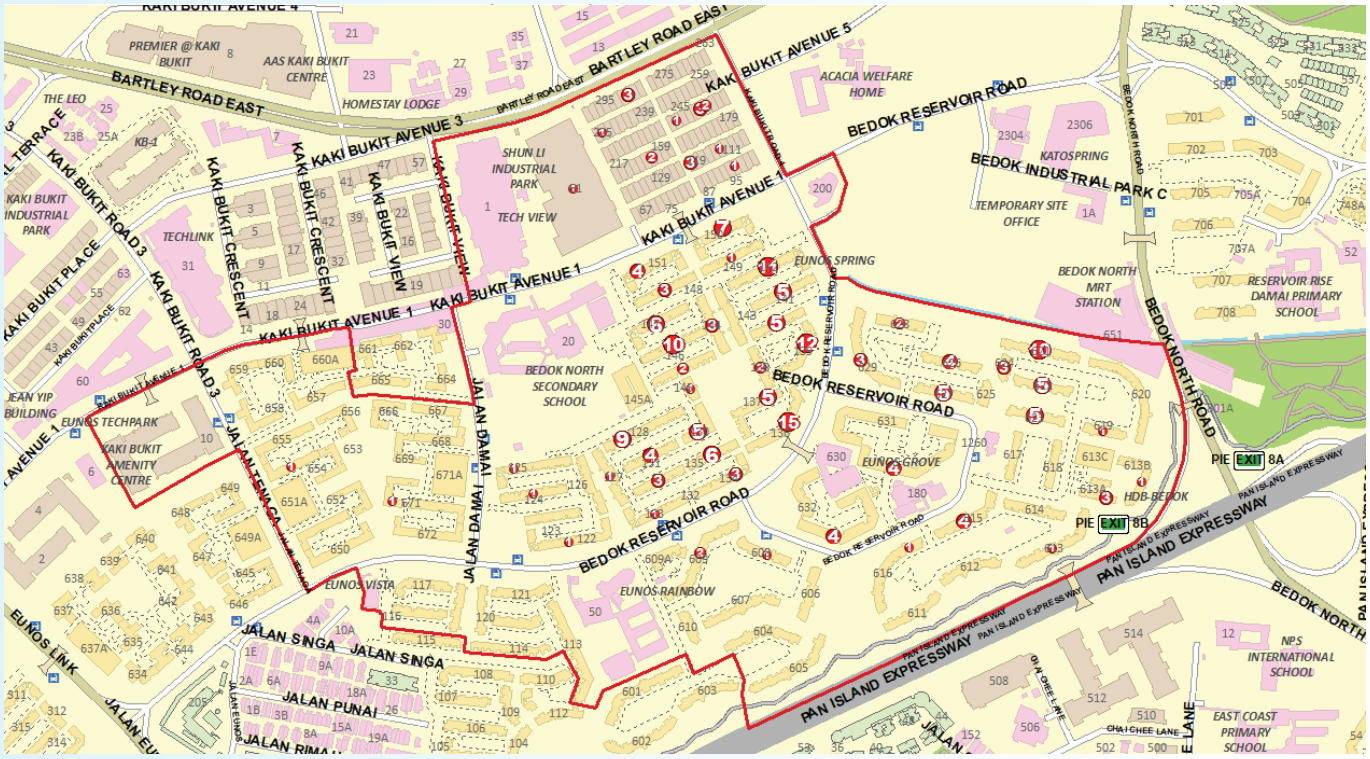


Figure 3.12
Geographical distribution of 206 dengue cases at Bedok Reservoir Rd (Blk 122, 124,125, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 144, 145, 146, 147, 148, 149, 150, 151, 608, 609, 613, 613A, 613B, 615, 616, 619, 621, 622, 623, 624, 626, 627, 628, 629, 631, 632) / Jln Damai (Blk 670) / Jln Tenaga (Blk 654) / Kaki Bt Ave 1 cluster



Cluster at Jurong West St 91 (Blk 933, 934, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 952) / Jurong West St 92 (Blk 920, 922, 925, 928) / Jurong West St 93 (Blk 966) / Yunnan Cres

On 13 March 2018, the MOH was notified of a dengue case, residing at block 950 Jurong West Street 91. Another case was notified on 22 March 2018 at block 947 Jurong West Street 91. As soon as the cases were notified, epidemiological investigations and vector control operations were carried out. A total of 92 cases were reported in the cluster. The cases had symptoms onset between 9 March 2018 and 21 May 2018. 52 cases had DEN-2. The epidemic curve is shown in Figure 3.13.

86 of the 92 cases (93.5%) were Singapore residents. Majority of the cases were in the 21-70 years' age group (79.3%). The female to male ratio was 1:1.5. The 92 cases included 11 students, 11 housewives, 2 unemployed persons, 7 retirees and 57 working adults. [Note that 4 (4.3%) cases were not tagged with occupation.] Figure 3.14 shows the geographical distribution of cases in the cluster.

A total of 159 mosquito breeding habitats were detected and destroyed. The common breeding habitats found in residential premises included domestic containers (e.g. pail, plastic containers etc.), ornamental containers (e.g. vases, porcelain container) and flower pot / plate/ tray. The common breeding habitats outdoors included drains, gully traps and discarded items. 77.4% of the breeding habitats were detected in residential premises and 22.6% in outdoor areas. Overall, the breeding detected comprised 84.9% of *Aedes aegypti*, 13.2% of *Aedes albopictus*, 0.6% of mixed *Aedes aegypti* and *Aedes albopictus*, and 1.3% of *Culex quinquefasciatus*. 11 profuse breeding habitats of 100 or more larvae each were detected in domestic containers, ornamental container, drain, gully tray, bin and puddle of water.

Figure 3.13
Time distribution of 92 dengue cases in the Jurong West St 91 (Blk 933, 934, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 952) / Jurong West St 92 (Blk 920, 922, 925, 928) / Jurong West St 93 (Blk 966) / Yunnan Cres cluster

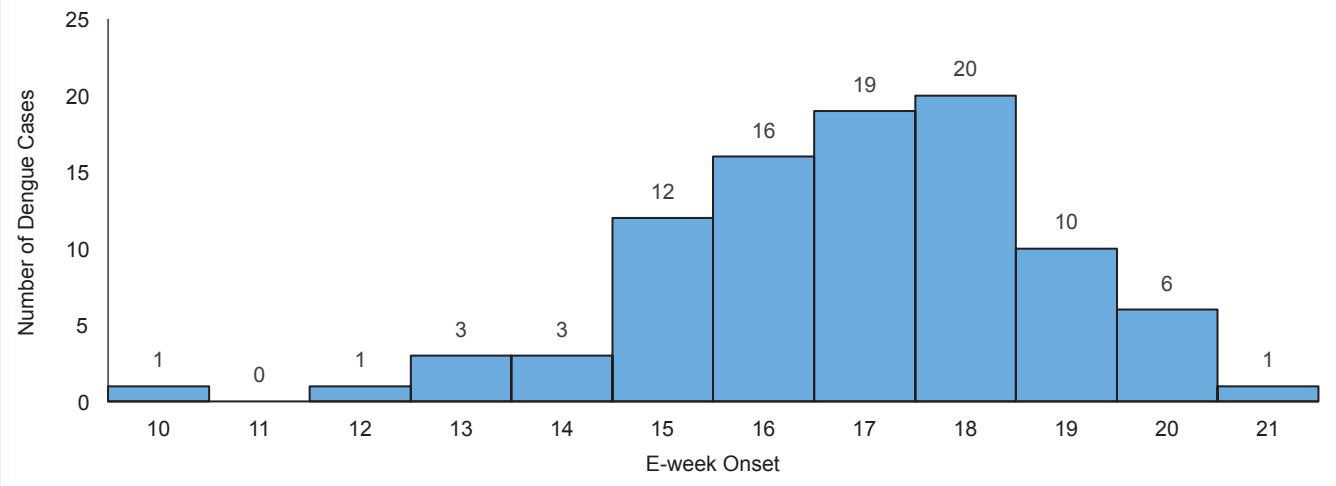
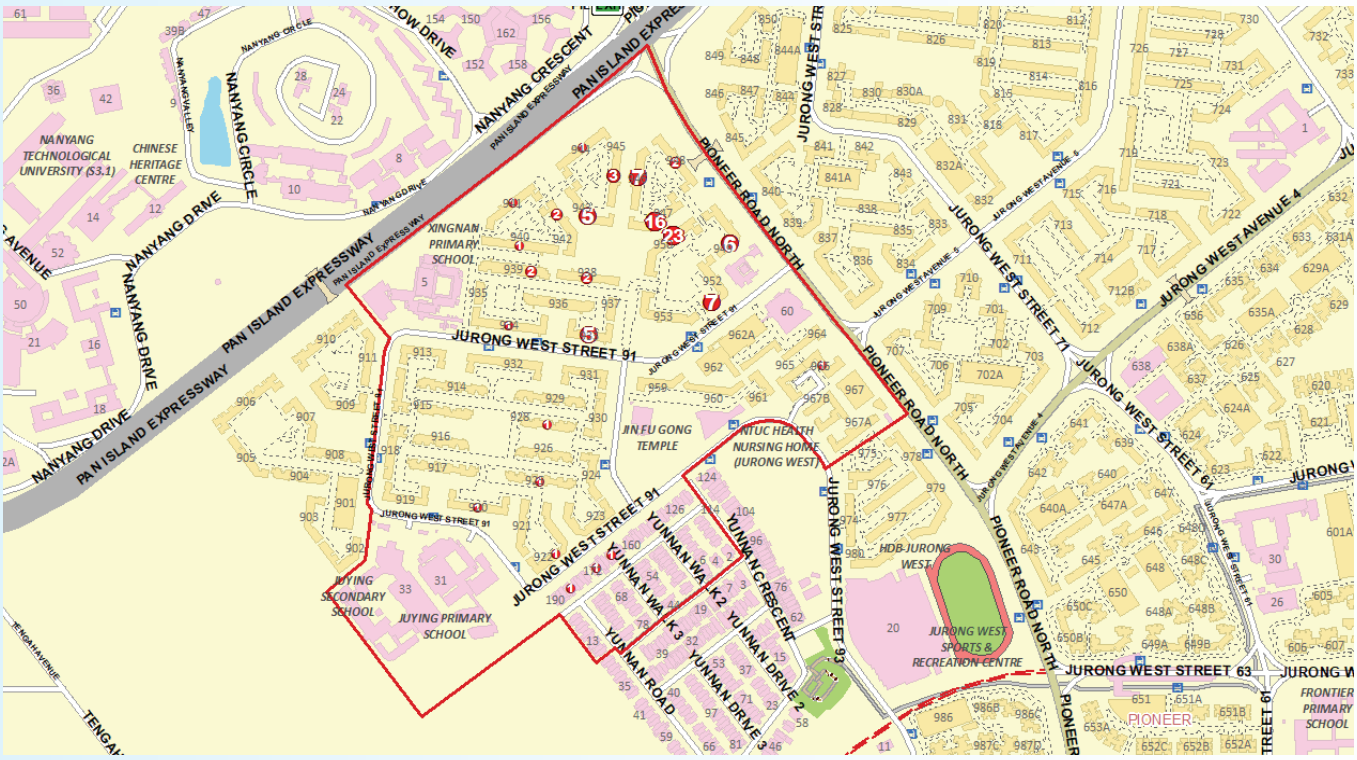


Figure 3.14
Geographical distribution of 92 dengue cases in the Jurong West St 91 (Blk 933, 934, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 952) / Jurong West St 92 (Blk 920, 922, 925, 928) / Jurong West St 93 (Blk 966) / Yunnan Cres cluster



LEPTOSPIROSIS

Leptospirosis is a zoonotic bacterial disease of variable clinical manifestations. The common presenting symptoms are fever, headache, chills, severe myalgia and conjunctival suffusion. The aetiologic agent *Leptospira* is a spiral organism and a member of the order *Spirochaetales* found mainly in infected wild and domestic animals (e.g. rodents or dogs, horses, cattle and pigs). The mode of transmission is through direct contact of the skin (especially if broken) or mucous membranes with the urine or bodily fluids (except saliva) tissues of infected animals. Contact with soil or vegetation contaminated by infected animals may also cause infection. Occasionally, leptospirosis has occurred following the ingestion of food contaminated by the urine of infected rats.

Confirmed cases are individuals who have clinically compatible symptoms with confirmatory laboratory findings such as detection of *Leptospira* via PCR. Suspect cases are individuals who have clinically compatible symptoms with either a positive *Leptospira* IgM antibodies or epidemiological risk factors.

A total of 41 suspect cases of leptospirosis were reported in 2018. There were no confirmed cases of leptospirosis reported. Of the 41 suspect cases, 32 were indigenous cases and nine were imported cases (Table 3.12). 24 involved Singapore residents and the remaining 17 cases comprised of 15 foreigners who worked in Singapore and two foreigners who came to Singapore for medical treatment (Tables 3.14). One death was reported, and classified as an imported case.

Figure 3.15
Weekly distribution of confirmed and suspect leptospirosis cases, 2017-2018

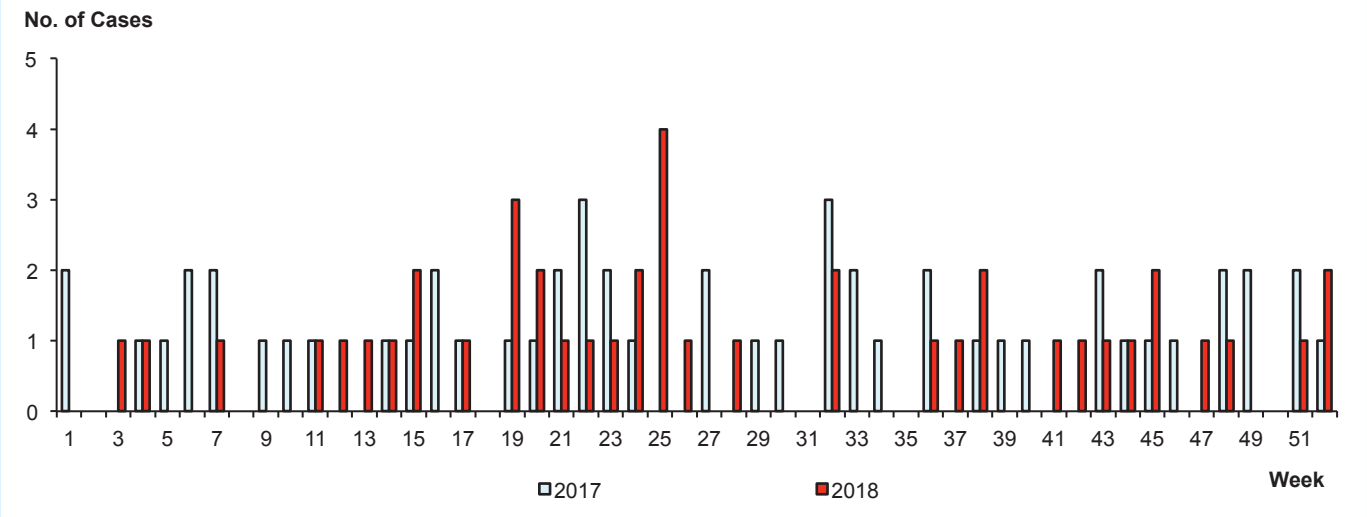


Table 3.12
Total number of notifications* received for confirmed and suspect leptospirosis cases, 2016-2018

Age group	2016^		2017		2018#	
	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	0	0	0
5-14	0	0	2	2	1	0
15-24	5	2	12	5	5	2
25-34	2	1	6	4	11	4
35-44	2	1	2	4	5	1
45-54	0	0	6	2	8	0
55-64	0	0	0	1	2	0
65+	0	0	1	0	0	0
Total	**9**	**4**	**29**	**18**	**32**	**7**

*Excluded tourists and foreigners seeking medical treatment in Singapore.
^Leptospirosis was added to the list of notifiable disease on 28 September 2016.
#Case definition was updated w.e.f from 1 January 2018.

The resident incidence rate was highest in the 15-24 years age group with an overall male to female ratio of 1.6:1 (Table 3.13). Among the three major ethnic groups, Indians had the highest incidence (Table 3.14).

Table 3.13
Age-gender distribution and age-specific resident incidence rate of reported leptospirosis cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	0	0	0	0
5-14	0	1	1	2.6	0.2
15-24	5	2	7	17.9	1.2
25-34	9	6	15	38.5	1.0
35-44	2	4	6	15.4	0.7
45-54	7	1	8	20.5	0.8
55-64	1	1	2	5.1	0.3
65+	0	0	0	0	0
Total	**24**	**15**	**39**	**100**	

^Excluded two foreigner seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 3.14
Ethnic-gender distribution and ethnic-specific incidence rate of reported leptospirosis cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	8	6	14	35.9	0.5
Malay	3	2	5	12.8	0.9
Indian	1	3	4	10.2	1.1
Others	1	0	1	2.6	0.8
Foreigners	11	4	15	38.5	0.9
Total	**24**	**15**	**39**	**100**	**0.7**

^Excluded two foreigner seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

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 Southeast Asia – has also caused several human cases of malaria. Symptoms of malaria include fever, headache, chills and vomiting.

In 2018, a total of 35 laboratory confirmed cases were reported, a decrease of 10.3% as compared to the 39 cases reported in 2017 (Figure 3.15). All 35 cases were imported, including eight tourists and two foreigners who came to Singapore for medical treatment (Table 3.15).

Figure 3.16
Weekly distribution of reported malaria cases, 2017-2018

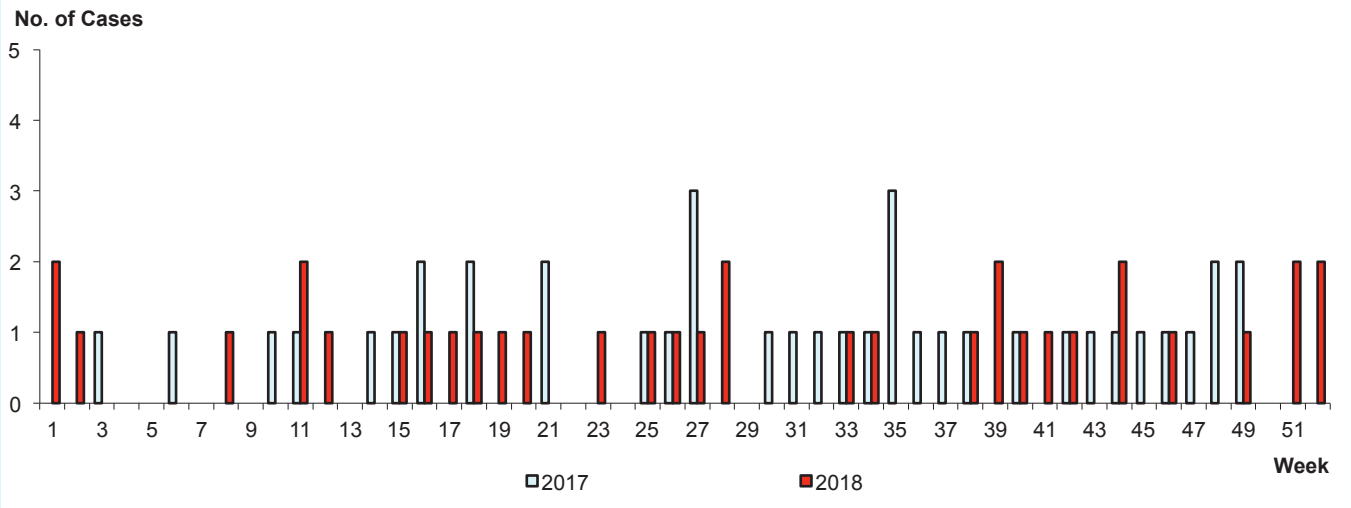


Table 3.15
Total number of notifications* received for malaria cases, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	0	0	0	0	0	0	0
5-14	0	1	0	1	0	0	0	0	0	0
15-24	0	8	0	8	0	6	0	2	0	2
25-34	0	25	0	13	0	11	0	10	0	10
35-44	0	9	0	4	0	1	0	7	0	6
45-54	0	5	0	1	0	2	0	2	0	5
55-64	0	3	0	3	0	1	0	1	0	1
65+	0	0	0	0	0	0	0	0	0	1
Total	**0**	**51**	**0**	**30**	**0**	**21**	**0**	**22**	**0**	**25**

*Excluded tourists and foreigners seeking medical treatment in Singapore

Among the imported cases, the resident incidence rate was highest in the 25-34 years age group, with an overall male to female ratio of 4:1 (Table 3.16). Among the three major ethnic groups, Indians had the highest incidence. (Table 3.17).

Table 3.16
Age-gender distribution and age-specific resident incidence rate of reported malaria cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	2	0	2	8.0	0.4
25-34	7	3	10	40.0	1.7
35-44	4	2	6	24.0	1.0
45-54	5	0	5	20.0	0.8
55-64	1	0	1	4.0	0.2
65+	1	0	1	4.0	0.2
Total	**20**	**5**	**25**	**100**	

^Excluded 10 tourists and foreigners seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 3.17
Ethnic-gender distribution and ethnic-specific incidence rate of reported malaria cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	2	1	3	12.0	0.1
Malay	1	1	2	8.0	0.4
Indian	4	1	5	20.0	1.4
Others	2	0	2	8.0	1.6
Foreigners	11	2	13	52.0	0.8
Total	**20**	**5**	**25**	**100**	**0.4**

^ Excluded 10 tourists and foreigners seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Malaria parasite species

The distribution of the cases by parasite species, for *P. vivax , P. falciparum* and *P. knowlesi* were 45.7%, 40.0% and 14.3%, respectively (Table 3.18).

Table 3.18
Classification of reported malaria cases by parasite species, 2018

Classification	Parasite species					Total (%)
	P.v.	P.f.	P.o.	P.m.	P.k.	
Imported**	16	14	0	0	5	35 (100)
Introduced	0	0	0	0	0	0
Indigenous	0	0	0	0	0	0
Cryptic	0	0	0	0	0	0
Induced	0	0	0	0	0	0
Total	**16**	**14**	**0**	**0**	**5**	**35 (100)**

P.v. - *Plasmodium vivax* P.f. - *Plasmodium falciparum* P.o. - *Plasmodium ovale*
P.m. - *Plasmodium malariae* P.k. - *Plasmodium knowlesi*
**Included relapsed cases that were imported.

Imported malaria cases

The majority of cases who had acquired malaria overseas were infected in India (34.3%) and Africa (34.3%). *P. vivax* accounted for 100% of the infections acquired in India, and *P. falciparum* accounted for 100% of the infections acquired in the African region (Table 3.19).

Table 3.19
Imported malaria cases by country/ region of origin and by parasite species, 2018

	Parasite species					
	P.v.	**P.f.**	**P.o.**	**P.m.**	**P.k.**	**Total (%)**
Southeast Asia						
Indonesia	1	1	0	0	0	2 (5.7)
Malaysia	0	1	0	0	3	4 (11.4)
Thailand	1	0	0	0	2	3 (8.5)
South Asia						
Pakistan	1	0	0	0	0	1 (2.9)
India	12	0	0	0	0	12 (34.2)
Africa						
Cameroon	0	2	0	0	0	2 (5.7)
Equatorial Guinea	0	1	0	0	0	1 (2.9)
Ghana	0	3	0	0	0	3 (8.5)
Guinea	0	1	0	0	0	1 (2.9)
Liberia	0	1	0	0	0	1 (2.9)
Mozambique	0	1	0	0	0	1 (2.9)
Nigeria	0	2	0	0	0	2 (5.7)
Tanzania	0	1	0	0	0	1 (2.9)
Other countries						
Papua New Guinea	1	0	0	0	0	1 (2.9)
Total	**16**	**14**	**0**	**0**	**5**	**35 (100)**

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

Most of the cases (79.5%) had onset of fever within three weeks of entry into Singapore (Table 3.20). For *P. vivax* malaria, 37.5% of cases did not develop symptoms until more than six weeks after entry, while for *P. falciparum*, 100% of cases developed symptoms less than two weeks into Singapore.

Table 3.20
Imported malaria cases by interval between period of entry and onset of illness# and by parasite species, 2018

Interval in weeks	Parasite species					
	P.v.	P.f.	P.o.	P.m.	P.k.	Total (%)
<2	9	14	0	0	4	27 (79.5)
2-3	0	0	0	0	1	1 (2.9)
4-5	0	0	0	0	0	0
6-7	1	0	0	0	0	1 (2.9)
8-9	1	0	0	0	0	1 (2.9)
10-11	0	0	0	0	0	0
12-13	2	0	0	0	0	2 (6.0)
14-15	0	0	0	0	0	0
16-17	0	0	0	0	0	0
18-19	0	0	0	0	0	0
20-23	0	0	0	0	0	0
24-27	0	0	0	0	0	0
28-31	1	0	0	0	0	1 (2.9)
32-35	1	0	0	0	0	1 (2.9)
36-39	0	0	0	0	0	0
40+	0	0	0	0	0	0
Total	**15***	**14**	**0**	**0**	**5**	**34 (100)**

*One asymptomatic *P. vivax* case was detected during blood screening.
P.v. - *Plasmodium vivax* P.f. - *Plasmodium falciparum* P.o. - *Plasmodium ovale*
P.m. - *Plasmodium malariae* P.k. - *Plasmodium knowlesi*

The 35 imported cases comprised 12 Singapore residents (34.3%), 11 work permit/employment pass holders (31.4%), one student pass holders (2.9%), one foreigner residing in Singapore (2.9%), two foreigners seeking medical treatment in Singapore (5.7%) and eight tourists (22.8%) (Table 3.21).

Table 3.21
Classification of imported malaria cases, 2017-2018

Classification	2017		2018	
	Cases	%	Cases	%
Local residents				
Singapore residents	5	12.8	12	34.3
Work permit/Employment pass holders	14	35.9	11	31.4
Student pass holders	2	5.1	1	2.9
Other foreigners	1	2.6	1	2.9
Foreigners seeking medical treatment	9	23.1	2	5.7
Tourists	8	20.5	8	22.8
Total	**39**	**100**	**35**	**100**

Out of 12 Singapore residents who contracted malaria overseas, three contracted malaria whilst on a business trip, two whilst employed overseas, one while doing missionary work and the rest were overseas for social visits or holiday. All were not known to have taken chemoprophylaxis (Tables 3.22 and 3.23).

Table 3.22
Purpose of travel for Singapore residents who contracted malaria overseas, 2014-2018

Purpose of Travel	2014	2015	2016	2017	2018
Social visits/holidays	5	5	0	4	6
Business	4	0	1	1	3
Military service	0	0	0	0	0
Volunteer/Missionary work	1	1	0	0	1
Employment	0	1	0	0	2
Total	**10**	**7**	**1**	**5**	**12**

Table 3.23
History of chemoprophylaxis for Singapore residents who contracted malaria overseas, 2014-2018

Chemoprophylaxis	2014	2015	2016	2017	2018
Took complete chemoprophylaxis	0	0	0	0	0
No chemoprophylaxis	10	7	1	5	12
Irregular/incomplete chemoprophylaxis	0	0	0	0	0
Total	**10**	**7**	**1**	**5**	**12**

MURINE TYPHUS

Murine typhus is a bacterial disease caused by *Rickettsia typhi* (formerly known as *Rickettsia mooseri*) and *Rickettsia felis*. The symptoms of murine typhus may include fever, rash, myalgia, abdominal pain, vomiting and nausea. The mode of transmission is by infective rat fleas that defecate rickettsiae while sucking blood from its host. This contaminates the bite site and other fresh skin wounds. Occasionally, cases occur following the inhalation of dried infective flea faeces.

Confirmed cases are individuals who have clinically compatible symptoms with either four-fold or greater increase in total antibody titre or *Rickettsia typhi* detected via PCR, immunohistochemistry (IHC) or culture. Suspect cases are individuals who have clinically compatible symptoms with either a positive immunoflorescent antibody test or epidemiological risk factors.

A total of 15 suspect cases and no confirmed cases of murine typhus were reported in 2018, compared to 11 suspect cases and one confirmed case in 2017 (Figure 3.16). Of the 15 suspect cases, 12 were indigenous cases and three were imported cases (Table 3.24). Four involved Singapore residents and the remaining 11 cases were foreigners working in Singapore (Table 3.26).

Figure 3.17
Weekly distribution of confirmed and suspected murine typhus cases, 2017-2018

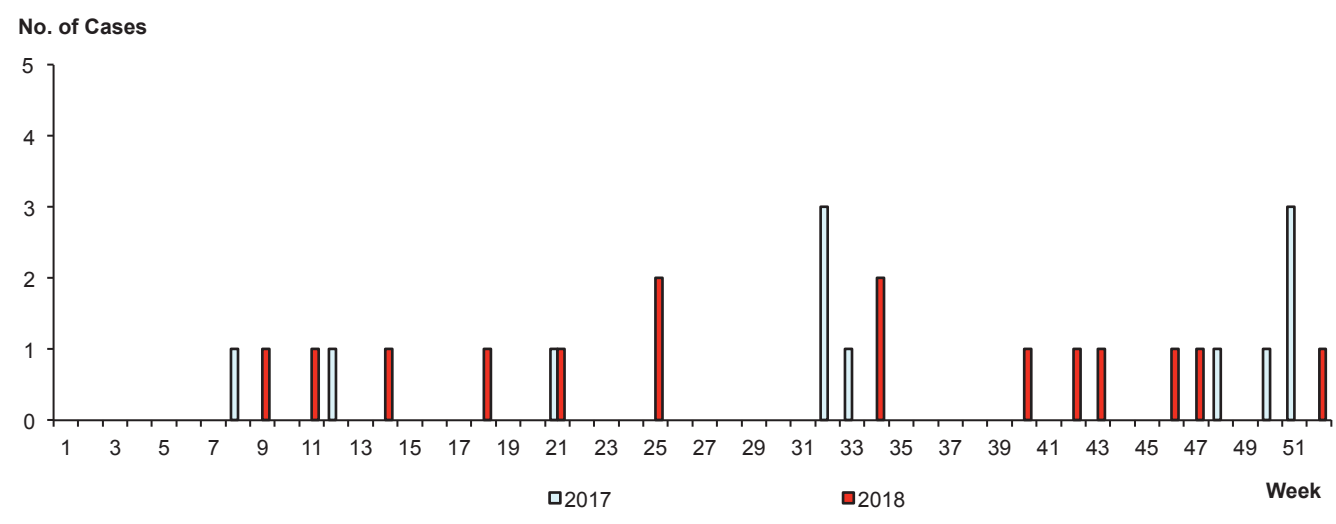


Table 3.24
Total number of notifications* received for confirmed and suspect murine typhus cases, 2016-2018

Age group	2016^		2017#		2018	
	Local	Imported	Local	Imported	Local	Imported
0-4	0	1	0	0	0	0
5-14	0	0	3	0	1	1
15-24	3	0	1	0	1	0
25-34	4	1	5	1	5	0
35-44	0	0	1	0	1	0
45-54	2	0	1	0	3	2
55-64	1	0	0	0	1	0
65+	0	0	0	0	0	0
Total	**10**	**2**	**11**	**1**	**12**	**3**

*Excluded tourists and foreigners seeking medical treatment in Singapore.
^Murine Typhus was added to the list of notifiable disease on 28 September 2016.
#Case definition was updated w.e.f from 1 January 2017.

The majority of cases were male, and the resident incidence rate was highest for the 45-54 years age group, with an overall male to female ratio of 6.5:1 (Table 3.25). Foreigners had the higher incidence rate compared to Singapore resident (Table 3.26).

Table 3.25
Age-gender distribution and age-specific resident incidence rate of reported suspect murine typhus cases, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	0	0	0	0
5-14	1	1	2	13.3	0.2
15-24	1	0	1	6.7	0
25-34	5	0	5	33.3	0
35-44	1	0	1	6.7	0
45-54	5	0	5	33.3	0.3
55-64	0	1	1	6.7	0.2
65+	0	0	0	0	0
Total	**13**	**2**	**15**	**100**	

* Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 3.26
Ethnic-gender distribution and ethnic-specific incidence rate of reported suspect murine typhus cases, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	3	1	4	26.7	0.1
Malay	0	0	0	0	0
Indian	0	0	0	0	0
Others	0	0	0	0	0
Foreigners	10	1	11	73.3	0.7
Total	**13**	**2**	**15**	**100**	**0.3**

* Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

ZIKA VIRUS INFECTION

Zika virus infection is transmitted by *Aedes mosquitoes*, similar to dengue. Only about one in five infections are symptomatic. The disease is usually self-limiting, although rarely, serious neurological complications have been reported. The disease is characterised by fever, rashes, joint pain, muscle pain, headache and conjunctivitis. Most symptoms last for four to seven days. The main vector in Singapore is the *Aedes aegypti* mosquito.

One laboratory confirmed case of Zika virus infection was reported in 2018, compared to 67 laboratory confirmed cases in 2017 (Figure 3.16). The indigenous case was a male Chinese in the 15-24 years age group (Table 3.27 and 3.28). There were no Zika clusters in 2018.

Figure 3.18
Weekly distribution of reported Zika cases, 2017-2018

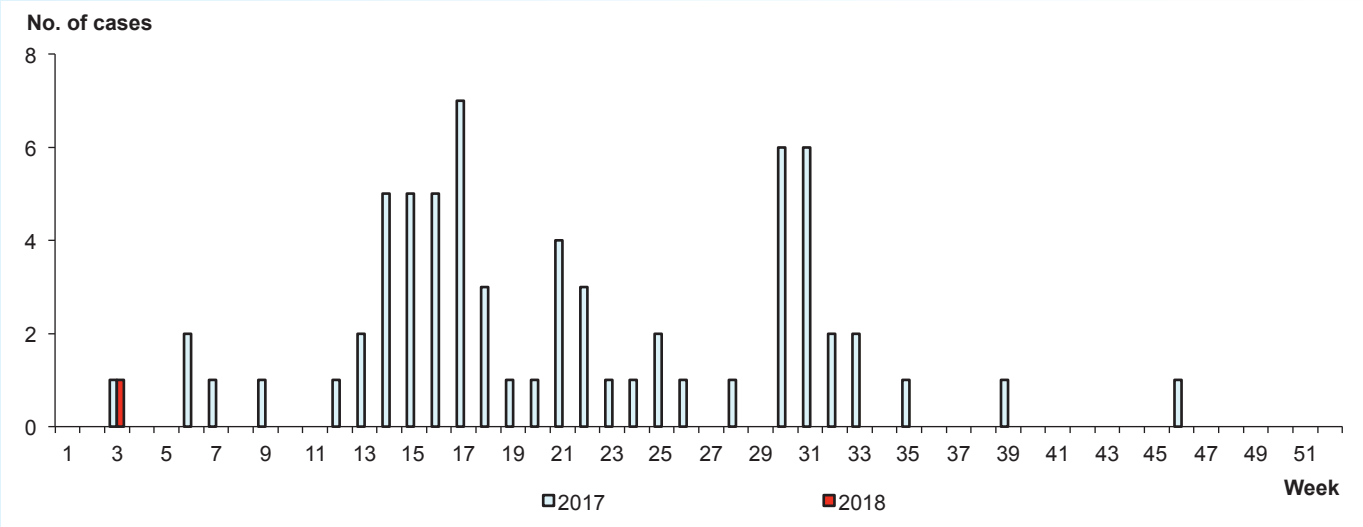


Table 3.27
Age-gender distribution and age-specific resident incidence rate of indigenous Zika cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	1	0	1	100	0.2
25-34	0	0	0	0	0
35-44	0	0	0	0	0
45-54	0	0	0	0	0
55-64	0	0	0	0	0
65+	0	0	0	0	0
Total	**1**	**0**	**1**	**100**	

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 3.28
Ethnic-gender distribution and ethnic-specific incidence rate of indigenous Zika cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	1	0	1	100	0.03
Malay	0	0	0	0	0
Indian	0	0	0	0	0
Others	0	0	0	0	0
Foreigners	0	0	0	0	0
Total	**1**	**0**	**1**	**100**	**0.02**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

CHAPTER 4

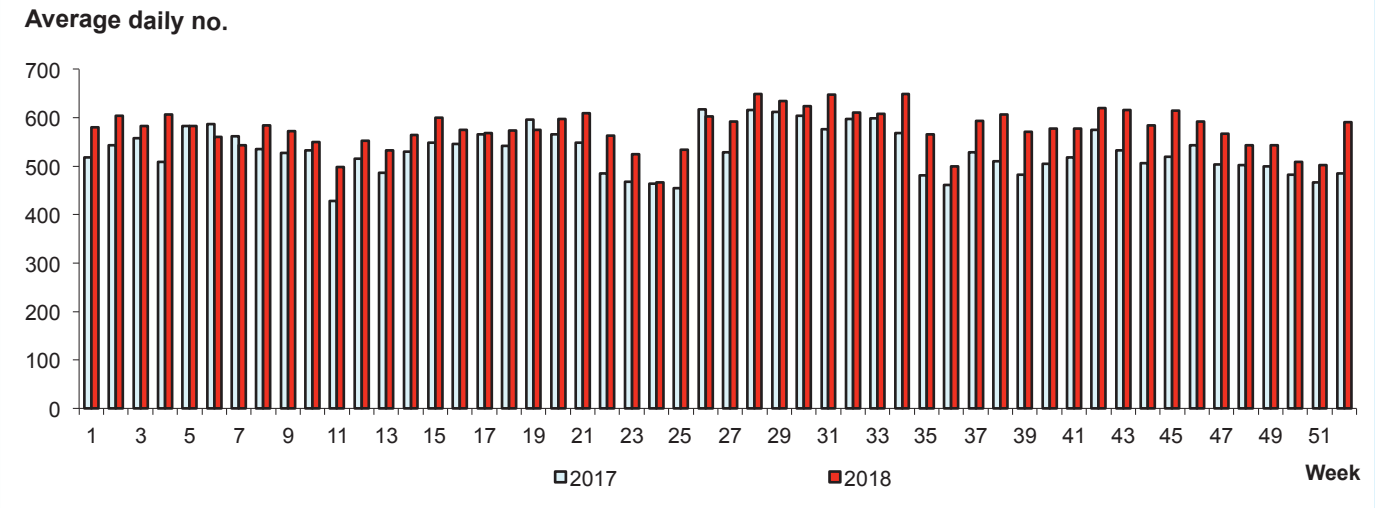
FOOD-BORNE DISEASES

Food-borne diseases are a result of ingestion of food or water contaminated with microorganisms (bacteria, virus, or parasite), toxins produced by harmful algae and bacterial species or present in specific fish species, or chemicals. Affected individuals commonly present with gastrointestinal symptoms. Contamination of food may occur at any stage in the process, from food production to consumption.

ACUTE DIARRHOEAL ILLNESS

There were a total of 158,366 attendances at polyclinics for acute diarrhoeal illness in 2018, an increase of 8.4% compared to the 146,092 seen in 2017. The weekly surveillance of acute diarrhoeal illness attendances showed a similar pattern to that of the previous year (Figure 4.1).

Figure 4.1
Weekly attendances of diarrhoeal illnesses at polyclinics, 2017-2018



BOTULISM

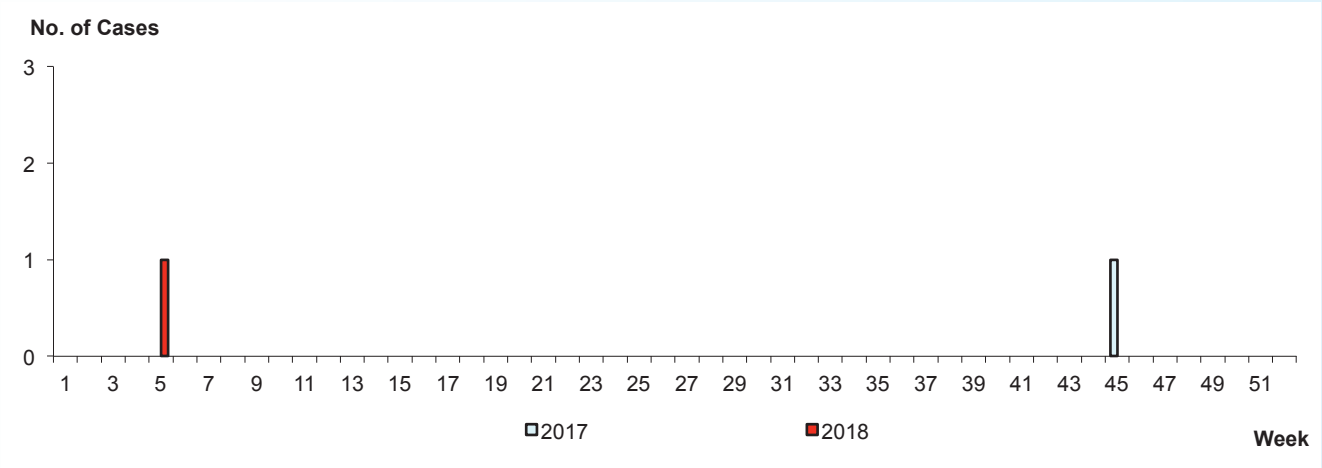
Botulism is a rare but serious illness caused by the neurotoxins of *Clostridium botulinum* that attack the body's nerves and cause difficulty in breathing, muscle paralysis, and even death. These gram-positive, spore formers are present in the environment but only grow and produce toxin under specific conditions in food products, in contaminated wounds, and in the intestinal tract of infants and adults with structurally or functionally compromised intestinal tracts.

Foodborne botulism occurs through ingestion of pre-formed toxins, usually involving home canned foods (e.g. fruits, vegetables, fish). Besides the food-borne route, other routes of botulism include: infant botulism through intestinal colonization by *C. botulinum* after ingestion of environmental dust/soil or food contaminated with spores (e.g. honey); wound botulism through introduction of *C. botulinum* spores into wounds, especially among injection drug users; inhalation botulism through inhalation of botulinum toxins when released in the form of an aerosol (e.g. bioterrorism); and iatrogenic botulism through cosmetic use of botulinum toxin.

Since botulism was made legally notifiable in September 2016, there were two isolated indigenous cases of infant botulism in 2017 and 2018.

In February 2018, there was one indigenous case of infant botulism involving a 22-week-old female (Figure 4.2). She was admitted to KK Women's and Children's Hospital after developing poor feeding and lethargy since 18 Jan 2018. Stool sample from the case subsequently tested positive for *C. botulinum* toxin. The child was reported to consume honey while being on mixed formula milk and breast milk. In addition, the child spent most of her time at her grandparents' home, where the grandmother did gardening. However, analysis of leftover honey, formula milk and soil were tested negative for *C. botulinum* toxin.

Figure 4.2
Weekly distribution of reported botulism cases, 2017-2018



CAMPYLOBACTERIOSIS

Campylobacter enteritis is an acute bacterial enteric disease of variable severity characterised by diarrhoea, abdominal pain, malaise, fever, nausea and vomiting. *Campylobacter jejuni,* and less commonly *Campylobacter coli,* are the usual causes of *Campylobacter* enteritis in humans. The mode of transmission is by ingestion of the organism in undercooked chicken or pork, contaminated food, water or unpasteurised milk.

A total of 427 cases of *Campylobacter* enteritis were reported in 2018, a decrease of 13.7% compared to 495 cases reported in 2017 (Figure 4.3). *Campylobacter jejuni* was isolated in the majority of the cases (Table 4.1). Of the 427 reported cases, 375 were indigenous cases and 36 were imported cases (Table 4.2); the remaining 16 cases comprised five tourists and 11 foreigners who travelled to Singapore to seek medical treatment.

The resident incidence was highest in the 0-4 years age group, with an overall male to female ratio of 1.5:1 (Table 4.3). Among the three major ethnic groups, Malays had the highest incidence rate followed by Chinese (Table 4.4).

Figure 4.3
Weekly distribution of reported campylobacteriosis cases, 2017-2018

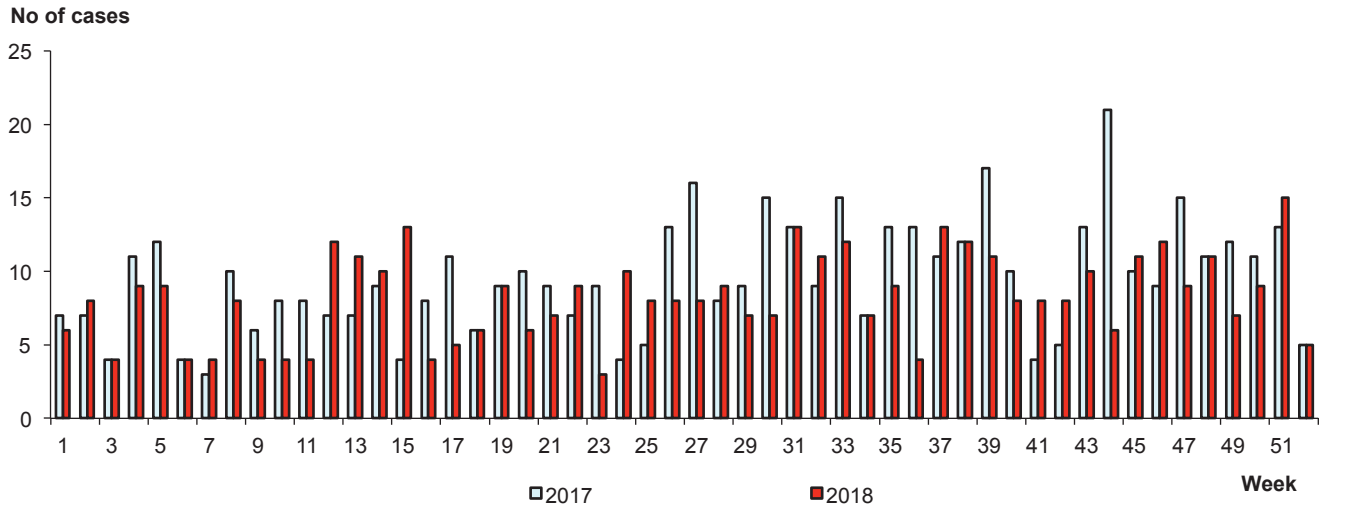


Table 4.1
Incidence rates of reported *Campylobacter* enteritis cases^, 2014-2018

Year	No. of cases caused by				Incidence rate per 100,000 population*
	C. jejuni	*C. coli*	Other species	Total	
2014	372	18	45	435	8.0
2015	334	31	55	420	7.6
2016	364	33	45	442	7.9
2017	379	40	76	495	8.8
2018	371	40	16	427	7.6

^ Excluded tourists and foreigners seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 4.2
Total number of notifications* received for reported *Campylobacter* enteritis, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	154	9	168	6	149	1	149	4	156	10
5-14	90	11	88	6	100	5	101	12	96	6
15-24	18	7	21	6	20	5	30	2	32	3
25-34	10	2	23	3	28	1	24	5	17	9
35-44	16	6	10	1	6	3	20	6	15	2
45-54	12	4	15	0	21	1	25	4	7	2
55+	70	13	63	4	82	2	92	1	52	4
Total	**370**	**52**	**388**	**26**	**406**	**18**	**441**	**34**	**375**	**36**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 4.3
Age-gender distribution and age-specific resident incidence rate of reported *Campylobacter* enteritis cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	103	63	166	40.4	71.7
5-14	67	35	102	24.8	20.7
15-24	26	9	35	8.5	5.8
25-34	9	17	26	6.3	1.6
35-44	11	6	17	4.1	1.8
45-54	3	6	9	2.2	1.1
55+	30	26	56	13.7	4.7
Total	**249**	**162**	**411**	**100**	

^Excluded five tourists and 11 foreigners seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 4.4
Ethnic-gender distribution and ethnic-specific incidence rate of reported *Campylobacter* enteritis cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	138	78	216	52.6	7.3
Malay	32	20	52	12.7	9.7
Indian	12	14	26	6.3	7.2
Others	18	13	31	7.5	24.1
Foreigners	49	37	86	20.9	5.2
Total	**249**	**162**	**411**	**100**	**7.3**

^Excluded five tourists and 11 foreigners seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

CHOLERA

Cholera is an acute bacterial enteric disease characterised in its severe form by sudden onset, profuse painless watery stools, nausea and vomiting. Untreated cases proceed rapidly to dehydration, acidosis, hypoglycaemia, circulatory collapse and renal failure. The usual causative agent in Singapore is *Vibrio cholerae* serogroup O1 which includes two biotypes, Classical and El Tor. Each of these biotypes can be further classified into serotypes Inaba, Ogawa and Hikojima. Other serogroups in addition to O1 are O139 and Non O. The mode of transmission is through ingestion of food or water contaminated with faeces or vomitus of infected persons.

In 2018, two imported cases of cholera involving one tourist and one work permit holder were reported (Figure 4.4 and Table 4.5). The overall incidence rate was zero per 100,000 population (Tables 4.6 and 4.7).

Figure 4.4
Weekly distribution of reported cholera cases, 2017-2018

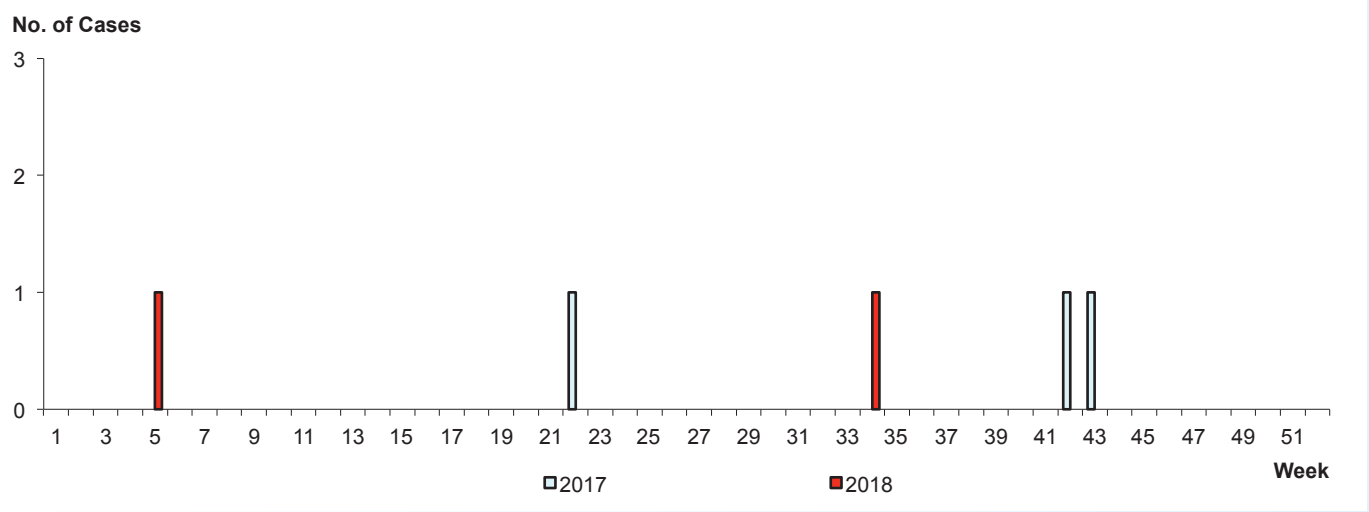


Table 4.5
Total number of notifications* received for reported cholera cases, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	1	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0
15-24	0	0	0	0	0	0	0	0	0	0
25-34	0	1	0	0	0	0	0	2	0	1
35-44	0	0	0	2	0	0	0	0	0	0
45-54	0	0	0	0	0	0	0	0	0	0
55-64	0	0	1	0	0	0	0	0	0	0
65+	0	0	0	0	0	0	0	0	0	0
Total	**0**	**2**	**1**	**2**	**0**	**0**	**0**	**2**	**0**	**1**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 4.6
Age-gender distribution and age-specific resident incidence rate of reported cholera cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	0	0	0	0	0
25-34	0	1	1	100	0
35-44	0	0	0	0	0
45-54	0	0	0	0	0
55-64	0	0	0	0	0
65+	0	0	0	0	0
Total	**0**	**1**	**1**	**100**	

^Excluded one tourist.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 4.7
Ethnic-gender distribution and ethnic-specific incidence rate of reported cholera cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	0	0	0	0	0
Malay	0	0	0	0	0
Indian	0	0	0	0	0
Others	0	0	0	0	0
Foreigners	0	1	1	100	0.1
Total	**0**	**1**	**1**	**100**	**0**

^Excluded one tourist.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

ENTERIC FEVERS

Enteric fevers (typhoid and paratyphoid) are systemic, bacterial diseases characterised by insidious onset of sustained fever, severe headache, malaise, anorexia. Other features may include a relative bradycardia, splenomegaly and non-productive cough (in the early stage of the illness). Constipation is more common than diarrhoea in adults. Causative organisms for the enteric fevers are *Salmonella* typhi and *Salmonella* paratyphi (types A or B), and infections are usually associated with travel to countries where these diseases are endemic. It is important to appreciate the difference between enteric fevers and non-typhoidal salmonellosis.

During the period 2014 to 2018, a total of 363 cases of enteric fever were reported, of which 266 (73.3%) cases were typhoid and 97 (26.7%) cases were paratyphoid. The majority (89.5%) were imported cases (Table 4.8).

Table 4.8
Classification of reported enteric fever cases, 2014-2018

Year	Typhoid	Paratyphoid		Total
		A	B	
2014	58 (52)	18 (17)	1 (0)	77 (69)
2015	49 (44)	25 (24)	2 (0)	76 (68)
2016	51 (39)	19 (17)	0 (0)	70 (56)
2017	65 (62)	16 (15)	0 (0)	81 (77)
2018	43 (40)	16 (15)	0 (0)	59 (55)
Total	**266 (237)**	**94 (88)**	**3 (0)**	**363 (325)**

( ) imported cases

In 2018, there were a total of 59 cases of enteric fevers comprising 43 cases of typhoid and 16 cases of paratyphoid A, a decrease of 27.2% compared to 81 cases reported in 2017 (Figure 4.5). Of the 43 reported cases of typhoid, 10 cases were Singapore residents, two were foreigners seeking medical treatment in Singapore, and one was a tourist. The remaining 30 cases comprised of 20 foreigners working in Singapore, six dependent pass holders and four student pass holders (Table 4.9). Of the 16 reported cases of paratyphoid, nine cases were Singapore residents, five were foreigners seeking medical treatment in Singapore, and two were dependent pass holders (Table 4.9).

Figure 4.5
Weekly distribution of reported enteric fever cases, 2017-2018

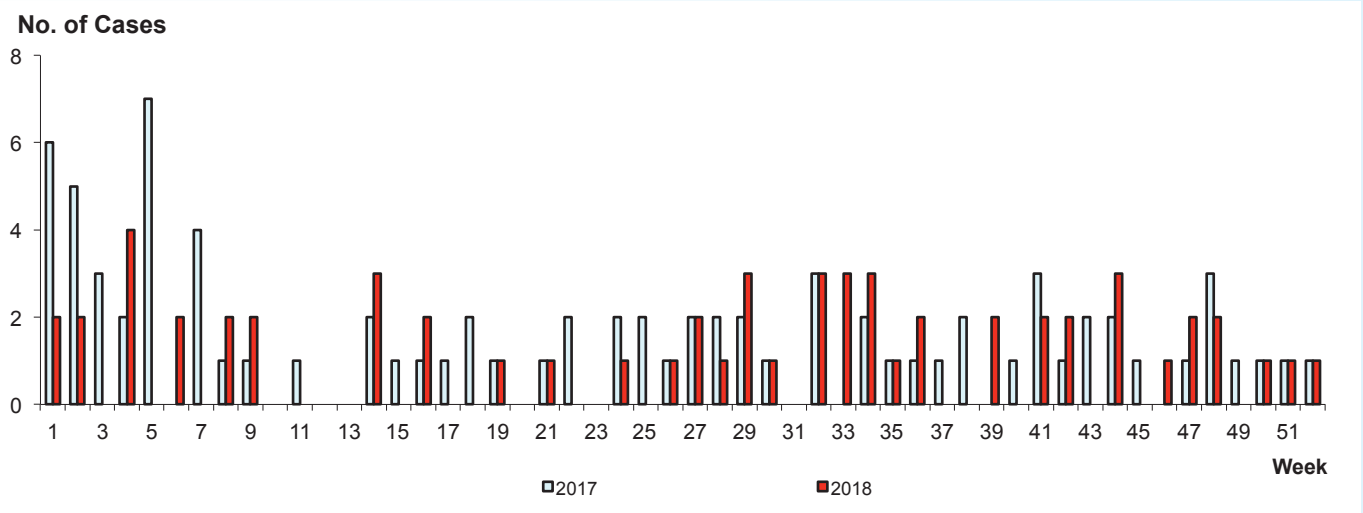


Table 4.9
Classification of reported typhoid and paratyphoid cases, 2018

Population Group	Typhoid No. (%)	Paratyphoid No. (%)
Singapore residents	10 (23.2)	9 (56.2)
Foreigners seeking medical treatment in Singapore	2 (4.7)	5 (31.3)
Tourists	1 (2.3)	0
Other categories of foreigners	30 (69.8)	2 (12.5)
Total	**43 (100)**	**16 (100)**

Typhoid

There were 43 reported cases of typhoid in 2018. During the period 2014 to 2018, majority of the cases of typhoid were imported, and in the 25-34 years age group (Table 4.10). The resident incidence rate was highest in 5-14 years age group in 2018 (Table 4.11). Among the three major ethnic groups, Indians had the highest incidence (Table 4.12).

Table 4.10
Total number of notifications* received for reported typhoid cases, 2014 – 2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	7	1	1	0	2	1	1	0	3
5-14	0	11	0	3	0	5	0	15	1	6
15-24	0	9	1	9	1	5	0	6	0	6
25-34	1	27	1	17	2	15	0	23	0	13
35-44	1	15	1	8	1	10	2	4	2	5
45-54	0	2	0	0	1	1	0	3	0	3
55-64	0	3	0	1	0	0	0	1	0	0
65+	0	3	0	0	1	1	0	1	0	1
Total	2	77	4	39	6	39	3	54	3	37

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 4.11
Age-gender distribution and age-specific resident incidence rate of reported typhoid cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	1	2	3	7.5	0
5-14	3	4	7	17.5	0.5
15-24	5	1	6	15.0	0.4
25-34	10	3	13	32.5	0.2
35-44	3	4	7	17.5	0.3
45-54	0	3	3	7.5	0.3
55-64	0	0	0	0	0
65+	1	0	1	2.5	0.2
Total	**23**	**17**	**40**	**100**	

^Excluded one tourist and two foreigners seeking medical treatment in Singapore.
* Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 4.12
Ethnic-gender distribution and ethnic-specific incidence rate of reported typhoid cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	3	0	3	7.5	0.1
Malay	0	2	2	5.0	0.4
Indian	1	2	3	7.5	0.8
Others	1	1	2	5.0	1.6
Foreigners	18	12	30	75.0	1.8
Total	**23**	**17**	**40**	**100**	**0.7**

^Excluded one tourist and two foreigners seeking medical treatment in Singapore.
* Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

The majority of cases acquired the infection from South Asia (67.6%) and Southeast Asia (32.4%) (Table 4.13). Most Singapore residents acquired the disease while overseas on vacation (66.7%) (Table 4.14).

Table 4.13
Imported typhoid cases by country/ region of origin^, 2017-2018

	2017	2018
	No. (%)	No. (%)
Southeast Asia		
Indonesia	5 (9.3)	9 (24.3)
Malaysia	2 (3.7)	0
Myanmar	9 (16.7)	2 (5.4)
Philippines	0	0
Thailand	0	1 (2.7)
South Asia		
Bangladesh	17 (31.5)	13 (35.2)
India	20 (37.0)	11 (29.7)
Pakistan	0	1 (2.7)
Others		
Republic of China, Taiwan	1 (1.8)	0
Total	**54 (100)**	**37 (100)**

^Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 4.14
Singapore residents who contracted typhoid overseas, 2014 – 2018

Purpose of travel	2014		2015		2016		2017		2018	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Vacation	14	77.8	13	92.9	12	85.7	16	88.9	6	66.7
Business/employment	2	11.1	1	7.1	2	14.3	0	0	2	22.2
Others	2	11.1	0	0	0	0	2	11.1	1	11.1
Total	**18**	**100**	**14**	**100**	**14**	**14**	**18**	**100**	**10**	**100**

Paratyphoid

There were 16 reported cases of paratyphoid in 2018. During the period 2014 to 2018, majority of the cases of paratyphoid were imported (Table 4.15). The resident incidence rate of paratyphoid was highest in 0-14 years age groups in 2018 (Table 4.16). Among the three major ethnic groups, Indians had the highest incidence rate (Table 4.17).

Table 4.15
Total number of notifications* received for reported paratyphoid cases, 2014 – 2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	1	0	1	0	0	0	2
5-14	0	1	0	2	0	2	0	2	0	2
15-24	0	5	0	3	0	2	0	3	0	1
25-34	1	7	1	7	1	7	0	2	0	0
35-44	0	0	0	4	0	4	0	2	0	1
45-54	0	1	0	3	0	0	1	1	0	2
55-64	0	1	0	1	0	0	0	1	0	2
65+	1	0	2	0	1	0	0	0	1	0
Total	**2**	**15**	**3**	**21**	**2**	**16**	**1**	**11**	**1**	**10**

* Excluded tourists and foreigners seeking medical treatment in Singapore

Table 4.16
Age-gender distribution and age-specific resident incidence rate of reported paratyphoid cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	1	1	2	18.2	0.5
5-14	2	0	2	18.2	0.5
15-24	0	1	1	9.1	0.2
25-34	0	0	0	0	0
35-44	0	1	1	9.1	0
45-54	0	2	2	18.2	0.3
55-64	1	1	2	18.2	0.3
65+	0	1	1	9.1	0.2
Total	**4**	**7**	**11**	**100**	

^Excluded five foreigners seeking medical treatment in Singapore
* Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 4.17
Ethnic-gender distribution and ethnic-specific incidence rate of reported paratyphoid cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	2	3	5	45.4	0.2
Malay	0	0	0	0	0
Indian	1	2	3	27.3	0.8
Others	0	1	1	9.1	0.8
Foreigners	1	1	2	18.2	0.1
Total	**4**	**7**	**11**	**100**	**0.2**

^Excluded five foreigners seeking medical treatment in Singapore.
* Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

The majority of cases acquire the infection from South Asia (60%) and Southeast Asia (40%) (Table 4.18). All Singapore residents acquired the disease while overseas on vacation (100%) (Table 4.19).

Table 4.18
Imported paratyphoid cases by country/ region of origin, 2017-2018

	2017	2018
	No. (%)	No. (%)
Southeast Asia		
Cambodia	0	3 (30)
Indonesia	4 (36.4)	1 (10)
South Asia		
Bangladesh	2 (18.2)	1 (10)
India	4 (36.3)	4 (40)
Pakistan	0	1 (10)
Others		
Australia	1 (9.1)	0
Total	**11 (100)**	**10 (100)**

^Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 4.19
Singapore residents who contracted paratyphoid overseas, 2014-2018

Purpose of travel	2014		2015		2016		2017		2018	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Vacation	8	88.9	10	83.3	6	66.7	5	71.4	8	100
Business/employment	1	11.1	2	16.7	3	33.3	0	0	0	0
Others	0	0	0	0	0	0	2	28.6	0	0
Total	**9**	**100**	**12**	**100**	**9**	**100**	**7**	**100**	**8**	**100**

HEPATITIS A

Hepatitis A is a viral infection spread from person to person by the faecal-oral route. Foods that are eaten raw or partially cooked, prepared with contaminated water or by an infected food handler, are common sources of infection. Clinical features include jaundice, fever, nausea and vomiting, loss of appetite, abdominal pain and tenderness, dark urine and pale stools.

There were 75 cases of laboratory confirmed acute hepatitis A in 2018 as compared to 81 cases in 2017 (Figure 4.6). 29 were imported and 39 were indigenous cases. The remaining seven cases involved two tourists and five foreigners seeking medical treatment in Singapore (Table 4.20).

The majority of the cases of hepatitis A were indigenous during the period 2017 to 2018 as compared to during the period 2014 to 2016 (Table 4.21).

Among local residents, the incidence rate of acute hepatitis A was highest in the 65+ years age group (2.6 per 100,000 population). The overall male to female ratio was 1.6:1 (Table 4.22). Among the three major ethnic groups, Malays had the highest incidence rate (Table 4.23).

Figure 4.6
Weekly distribution of reported acute hepatitis A cases, 2017-2018

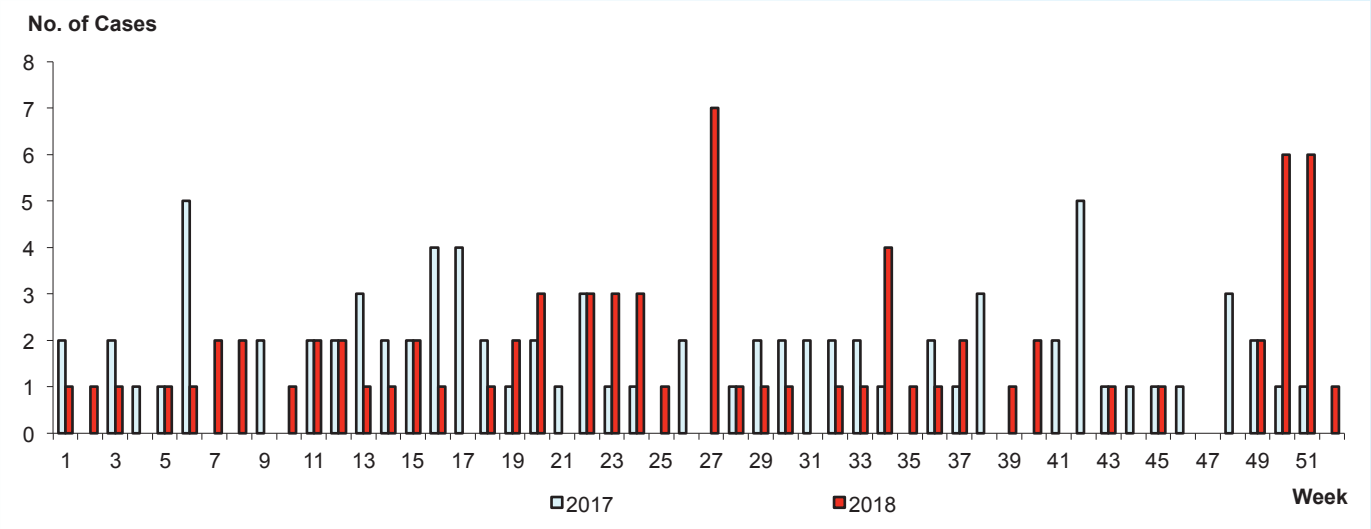


Table 4.20
Classification of reported acute hepatitis A cases, 2018

Population group	No. of cases (%)
Singapore residents	56 (74.7)
Work permit holders/other foreigners	12 (16.0)
Foreigners seeking medical treatment in Singapore	5 (6.7)
Tourists	2 (2.6)
Total	**75 (100)**

Table 4.21
Total number of notifications* received for acute hepatitis A, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	1	0	0	0	0	0	0	0	1
5-14	0	4	0	4	0	3	3	2	0	1
15-24	3	8	5	7	1	5	5	5	4	2
25-34	7	17	2	11	1	13	14	12	5	9
35-44	2	8	4	5	1	5	5	5	6	4
45-54	0	7	2	1	2	2	3	4	7	7
55-64	1	1	1	1	1	0	5	4	5	3
65+	8	0	2	0	2	2	14	0	12	2
Total	**21**	**46**	**16**	**29**	**8**	**30**	**49**	**32**	**39**	**29**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 4.22
Age-gender distribution and age-specific resident incidence rate of acute hepatitis A cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	1	1	1.5	0
5-14	0	1	1	1.5	0
15-24	5	1	6	8.8	1.0
25-34	11	3	14	20.6	1.6
35-44	10	0	10	14.7	1.2
45-54	8	6	14	20.6	2.3
55-64	2	6	8	11.8	1.2
65+	6	8	14	20.5	2.6
Total	**42**	**26**	**68**	**100**	

^Excluded two tourists and five foreigners seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 4.23
Ethnic-gender distribution and ethnic-specific incidence rate of acute hepatitis A cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	23	12	35	51.5	1.2
Malay	9	9	18	26.5	3.4
Indian	2	0	2	2.9	0.6
Others	0	1	1	1.5	0.8
Foreigners	8	4	12	17.6	0.7
Total	**42**	**26**	**68**	**100**	**1.2**

^Excluded two tourists and five foreigners seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Imported acute hepatitis A

Of the 75 cases of acute hepatitis A, 36 (48.0%) cases acquired the infection overseas (Table 4.24). The majority of the cases acquired the infection from Southeast Asia (51.3%) and South Asia (38.5%) (Table 4.25).

Table 4.24
Classification of imported acute hepatitis A cases, 2018

Population group	No. of cases (%)
Local residents	
Residents who contracted the disease overseas	21 (58.3)
Work permit/employment/dependent pass holders	8 (22.2)
Foreigners seeking medical treatment	5 (13.9)
Tourists	2 (5.6)
Total	**36 (100)**

Table 4.25
Imported acute hepatitis A cases by country/ region of origin, 2018

Country/ region of origin	No. of cases (%)
Southeast Asia	
Indonesia	7 (17.9)
Malaysia	7 (17.9)
Myanmar	1 (2.6)
Cambodia	1 (2.6)
Thailand	4 (10.3)
South Asia	
India	9 (23.0)
Bangladesh	4 (10.3)
Pakistan	1 (2.6)
Nepal	1 (2.6)
Others	
Madagascar	1 (2.6)
Papua New Guinea	1 (2.6)
Taiwan	2 (5.0)
Total	**39* (100)**

*Count is higher than table 4.24 as some individuals visited more than one country

HEPATITIS E

Similar to hepatitis A, hepatitis E is also a viral infection spread from person to person by the faecal-oral route. The most common documented medium of transmission is faecal-contaminated drinking water. Clinical features include jaundice, fever, nausea and vomiting, loss of appetite, abdominal pain and tenderness, dark urine and pale stools.

There were 54 cases of laboratory-confirmed acute hepatitis E in 2018, compared to 76 cases in 2017 (Figure 4.7). They comprised 44 Singapore residents and 10 work permit holders (Table 4.26). Among Singapore residents and work permit holders, 42 were local and 12 were imported cases.

During the period 2014 to 2018, majority of the cases of hepatitis E were indigenous, and in the 65+ years age group (Table 4.27).

Among local residents, the incidence rate was highest in the 65+ years age group (6.2 per 100,000 population). The overall male to female ratio was 2.4:1 (Table 4.28). Of the three main ethnic groups, Chinese had the highest incidence rate (Table 4.29).

Figure 4.7
Weekly distribution of reported acute hepatitis E cases, 2017-2018

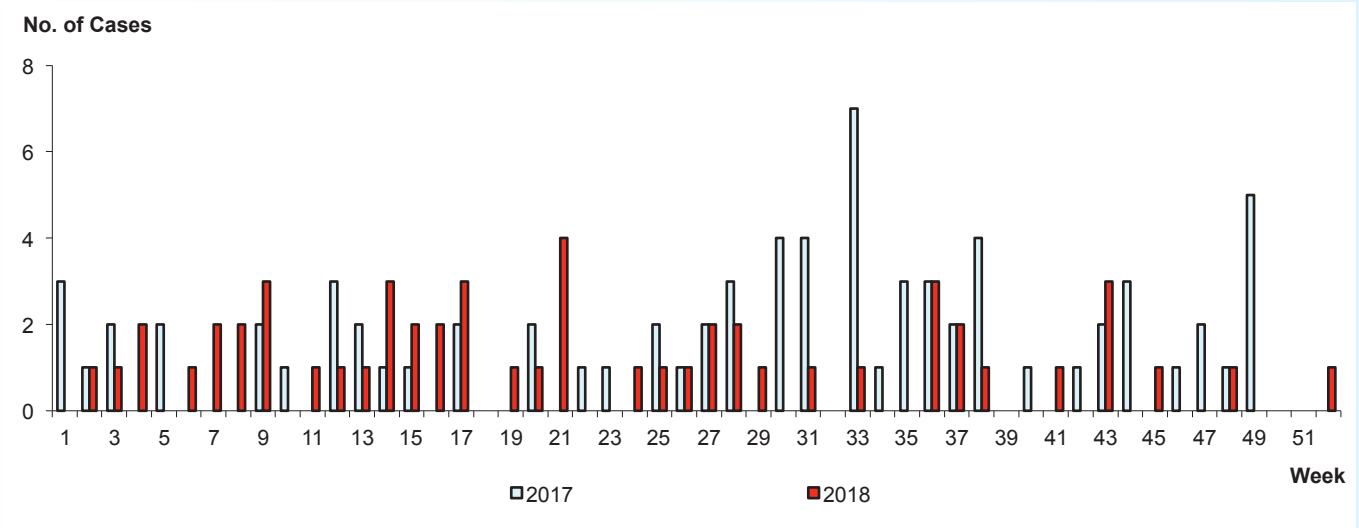


Table 4.26
Classification of reported acute hepatitis E cases, 2018

Population group	No. of cases (%)
Singapore residents	44 (81.5)
Work permit holders/other foreigners	10 (18.5)
Foreigners seeking medical treatment in Singapore	0 (0)
Tourists	0 (0)
Total	**54 (100)**

Table 4.27
Total number of notifications* received for acute hepatitis E cases, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	1	0	0	0	0	0
15-24	0	1	0	5	0	0	3	1	0	1
25-34	3	5	1	3	0	4	7	5	4	6
35-44	1	8	2	1	6	2	4	1	6	2
45-54	6	2	9	0	9	2	5	1	11	1
55-64	17	3	17	6	17	6	19	2	7	1
65+	15	2	13	1	23	2	20	2	14	1
Total	**42**	**21**	**42**	**16**	**56**	**16**	**58**	**12**	**42**	**12**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 4.28
Age-gender distribution and age-specific resident incidence rate of acute hepatitis E cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	1	0	1	1.9	0
25-34	8	2	10	18.5	1.6
35-44	4	4	8	14.8	2.2
45-54	9	3	12	22.2	4.4
55-64	5	3	8	14.8	2.8
65+	11	4	15	27.8	6.2
Total	**38**	**16**	**54**	**100**	

^Excluded tourists and foreigners seeking medical treatment in Singapore.
* Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 4.29
Ethnic-gender distribution and ethnic-specific incidence rate of acute hepatitis E cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	27	14	41	75.9	1.4
Malay	0	0	0	0	0
Indian	2	0	2	3.7	0.6
Others	0	1	1	1.9	0.8
Foreigners	9	1	10	18.5	0.6
Total	**38**	**16**	**54**	**100**	**1.0**

^Excluded tourists and foreigners seeking medical treatment in Singapore.
* Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Imported Acute Hepatitis E

Of 54 cases of Hepatitis E, 12 (22.2%) cases acquired the infection overseas (Table 4.30). The majority of the cases acquired the infection from South Asia (66.6%) and Southeast Asia (33.4%) (Table 4.31).

Table 4.30
Imported acute hepatitis E cases by population group, 2018

Population group	No. of cases (%)
Local residents	
Residents who contracted the disease overseas	4 (33.3)
Work permit/employment/dependent pass holders	8 (66.7)
Foreigners seeking medical treatment	0 (0)
Tourists	0 (0)
Total	**12 (100)**

Table 4.31
Imported acute hepatitis E cases by country/ region of origin, 2018

Country/ region of origin	No. of cases (%)
Southeast Asia	
Indonesia	2 (16.8)
Malaysia	1 (8.3)
Thailand	1 (8.3)
South Asia	
Bangladesh	4 (33.3)
India	4 (33.3)
Total	**12 (100)**

Hepatitis E Virus Genotypes

Genotyping was done by the National Public Health Laboratory for 31 laboratory-confirmed cases. 10 (32.3%) were genotype 1, 16 (51.6%) were genotype 3, and the genotypes for the remaining samples were indeterminate.

SALMONELLOSIS

Salmonellosis is a bacterial disease commonly presenting as acute enterocolitis, with sudden onset of fever, headache, abdominal pain, diarrhoea, nausea and sometimes vomiting. Dehydration, especially among infants or in the elderly, may be severe. The causative pathogen, *Salmonella* is a genus of gram-negative, facultative anaerobic motile rod-shape bacteria. It is divided into two species, *Salmonella enterica* and *Salmonella bongori*. *Salmonella enterica* is further subdivided into subspecies and serotypes based on biochemical and antigenic reactions. The majority of *Salmonella* serotypes belong to *S. enterica* subsp. *enterica*. Within *S. enterica* subsp. *enterica*, the most common O-antigen serogroups identified are from A to E. Numerous serotypes of *Salmonella* are pathogenic for both animals and human; that include the most commonly reported *Salmonella enterica* serovar Typhimurium (*S.* Typhimurium) and *Salmonella enterica* serovar Enteritidis (*S.* Enteritidis).

Poultry is the most common source of human salmonellosis. Consumption of contaminated meat and eggs is also a frequent cause. A wide range of domestic and wild animals including poultry, swine, cattle, rodents and pets may act as reservoirs for salmonellosis.

A total of 1,620 laboratory-confirmed cases of salmonellosis were reported in 2018, a decrease of 19.4% compared to 2,010 cases reported in 2017 (Figure 4.8). *Salmonella* Group D was the predominant serogroup identified in 2018 (Table 4.32). Of these Group D cases, 220 cases were caused by *S.* Enteritidis.

Figure 4.8
Weekly distribution of reported salmonellosis cases, 2017-2018

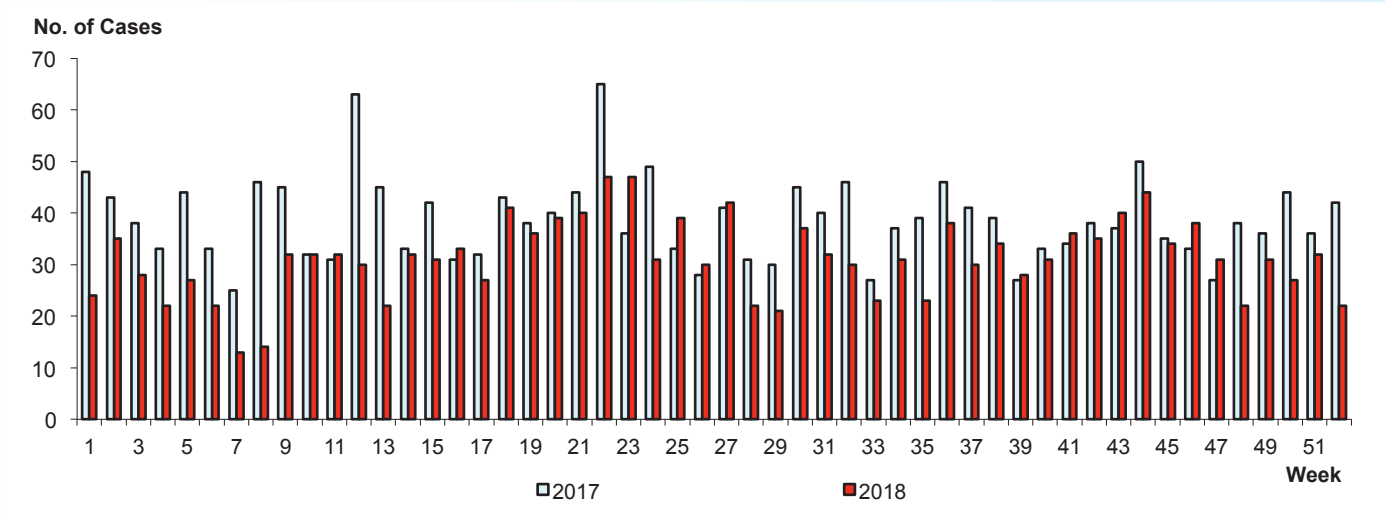


Table 4.32
Reported salmonellosis cases by serogroups, 2018

Salmonella serogroups	No. of cases	Incidence rate per 100,000 population*
Enterica-D	577	10.2
Enterica-B	401	7.1
Enterica-C	165	2.9
Enterica-E	64	1.1
Enterica-E/G	22	0.4
Enterica-G	6	0.1
Enterica-A	0	0
Enterica-Unspecified	385	6.8
Total	**1,620**	**28.7**

*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

***Salmonella* Enteritidis**

Of the 220 cases reported in 2018, 196 were Singapore residents, 22 were work permit holders and two were foreigners seeking medical treatment in Singapore (Table 4.33).

During the period 2014 to 2018, majority of the cases of *S.* Enteritidis were indigenous, and in the 65+ years age group (Table 4.34). Among the local residents, the incidence rate was highest in the 65+ years age group (Table 4.35). Among the three major ethnic groups, Malays had the highest incidence rate (Table 4.36).

Table 4.33
Classification of reported acute *S.* Enteritidis cases, 2018

Population group	No. of cases (%)
Singapore residents	196 (89.1)
Work permit holders/other foreigners	22 (10.0)
Foreigners seeking medical treatment in Singapore	2 (0.9)
Tourists	0 (0)
Total	**220 (100)**

Table 4.34
Total number of notifications* received for reported *S.* Enteritidis cases, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	71	0	34	0	21	1	27	1	28	0
5-14	15	1	16	1	7	0	6	0	5	0
15-24	20	0	12	1	19	1	21	0	16	1
25-34	35	1	34	0	40	2	22	2	16	0
35-44	28	0	34	0	30	0	31	1	15	1
45-54	36	1	35	0	42	0	28	2	23	0
55-64	61	2	54	2	40	1	35	4	32	1
65+	116	1	101	0	103	0	106	4	78	2
Total	**382**	**6**	**320**	**4**	**302**	**5**	**276**	**14**	**213**	**5**

*Excluded tourists and foreigners seeking medical treatment in Singapore

Table 4.35
Age-gender distribution and age-specific resident incidence rate of reported *S.* Enteritidis cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	16	12	28	12.8	13.5
5-14	2	2	4	1.8	0.7
15-24	12	1	13	6.0	2.3
25-34	8	6	14	6.4	1.9
35-44	7	10	17	7.8	2.1
45-54	15	8	23	10.6	3.6
55-64	19	7	26	11.9	5.6
65+	49	44	93	42.7	14.4
Total	**128**	**90**	**218**	**100**	

^Excluded two foreigners seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 4.36
Ethnic-gender distribution and ethnic-specific incidence rate of reported *S.* Enteritidis cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	79	56	135	61.9	4.5
Malay	25	15	40	18.3	7.5
Indian	7	6	13	6.0	3.6
Others	2	5	7	3.2	5.4
Foreigners	15	8	23	10.6	1.4
Total	**128**	**90**	**218**	**100**	**3.9**

*Excluded two foreigners seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

FOOD POISONING

There were 398 notifications of food poisoning events involving 3,165 cases in 2018, compared with 347 notifications with 1,825 cases in 2017 (Figure 4.9). In 2018 (Table 4.37), majority of the notifications involved restaurant (others), and majority of the cases reported to have developed gastroenteritis symptoms after consuming catered food.

Figure 4.9
Notifications of food poisoning in Singapore, 1999-2018

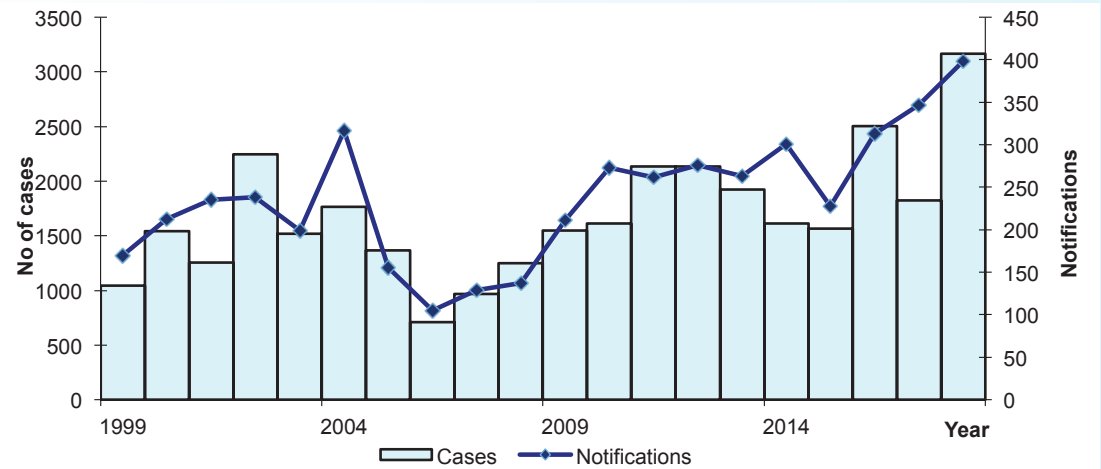


Table 4.37
Food poisoning notifications by type of food establishments, 2018

Type of food establishments	No. of notifications	No. of food establishments involved	No. of cases
General outlets			
Bakery	5	5	16
Canteens			
School	6	6	128
Tertiary Institution	0	0	0
Others	2	2	9
Caterer (licensed)	24	24	1,022
Eating house	51	51	215
Fair (food fair)	3	3	8
Fair (others)	3	3	9
Food court	25	23	56
Foodshop (takeaway)	18	18	74
Hawker centre	27	26	83
Other licensed premises	6	6	13
Restaurants			
In Hotel	21	19	189
Fast Food	16	16	42
Others	156	153	733
Supermarket	3	3	9
Snackbar	12	12	109
Food factory	13	13	204
Sub-total (General outlets)	**391**	**383**	**2,919**
In house kitchens			
Army	0	0	0
Childcare centre	3	3	73
Hotel	0	0	0
Nursing home	0	0	0
Police	0	0	0
Prison	0	0	0
School	0	0	0
Workers dormitory	0	0	0
Others	0	0	0
Unlicensed premises	4	4	173
Sub-total (Others)	**7**	**7**	**246**
Total	**398**	**390**	**3,165**

CHAPTER 5

BLOOD-BORNE & SEXUALLY TRANSMITTED DISEASES

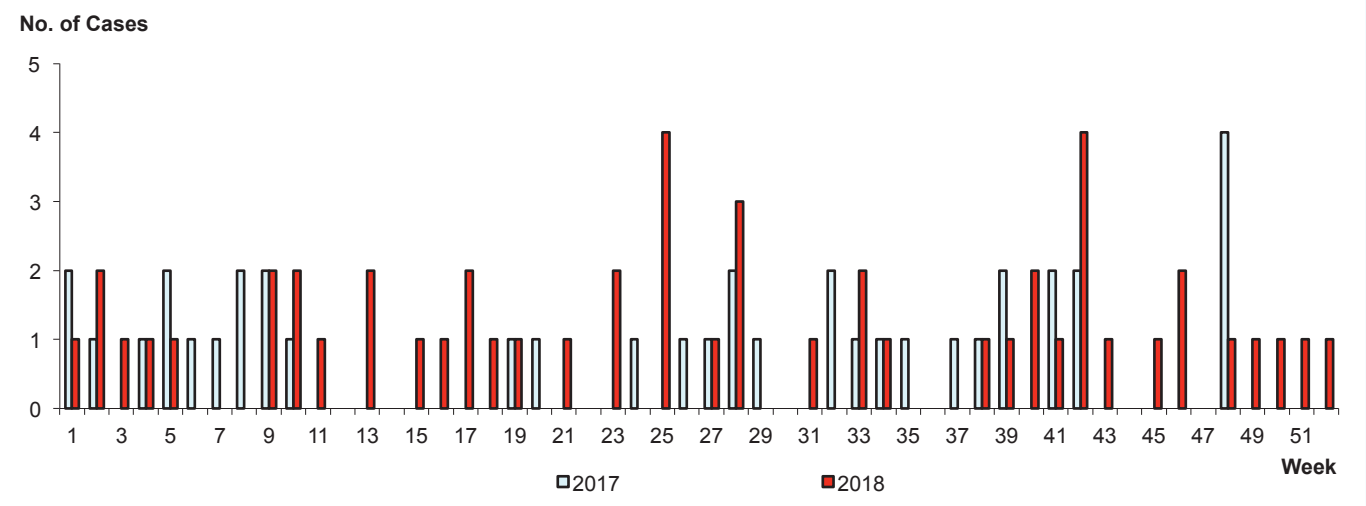
Exposure to blood and other body fluids can transmit diseases. Sexually transmitted infections (STIs) are spread predominantly by sexual contact, sometimes through non-sexual means such as via blood or blood products. STIs can have serious health consequences beyond the immediate impact of the infection itself. HIV, for example, is an incurable viral infection that requires lifelong treatment.

HEPATITIS B

Hepatitis B virus is a small DNA virus that belongs to the *Hepadnaviridae* family. Infection with HBV may cause acute hepatitis which is characterised by jaundice and abdominal pain. Some patients develop chronic hepatitis which may lead to liver cirrhosis and liver cancer, while some have a persistent but asymptomatic carrier state. Patients with these chronic infection states can transmit the disease to susceptible persons, including vertical transmission from mother to child. Cure remains elusive currently.

A total of 52 cases of acute hepatitis B were reported in 2018, compared to 38 cases reported in 2017 (Figure 5.1). Of the 52 cases, 51 were serologically confirmed with the presence of hepatitis B surface antigen (HBsAg) or nucleic acid, and anti-HBc IgM antibody which is associated with acute clinical presentation. The remaining case was a seroconversion case with a documented negative HBsAg result followed within six months by a positive test.

Figure 5.1
Weekly distribution of reported acute hepatitis B cases, 2017-2018



The resident incidence rate was highest in the 35-44 years age group and an overall male to female ratio among cases was 3.6:1 (Table 5.1). Among the three major ethnic groups, Chinese had the highest incidence rate (Table 5.2). The majority of the cases (80.4%) were local cases (Table 5.3).

Table 5.1
Age-gender distribution and age-specific resident incidence rate of acute hepatitis B cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	1	0	1	2.0	0.2
25-34	9	5	14	27.4	0.3
35-44	15	5	20	39.2	1.3
45-54	7	1	8	15.7	0.6
55-64	6	0	6	11.8	1.0
65+	2	0	2	3.9	0.4
Total	**40**	**11**	**51**	**100**	

^ Excluded one foreigner seeking medical treatment in Singapore
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 5.2
Ethnic-gender distribution and ethnic-specific incidence rate of acute hepatitis B cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	16	3	19	37.2	0.6
Malay	1	0	1	2.0	0.2
Indian	1	0	1	2.0	0.3
Others	1	1	2	3.9	1.6
Foreigners	21	7	28	54.9	1.7
Total	**40**	**11**	**51**	**100**	**0.9**

^ Excluded one foreigner seeking medical treatment in Singapore
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 5.3
Total number of notifications received for acute hepatitis B cases^, 2014-2018

Age Group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0
15-24	1	1	0	0	3	0	2	1	1	0
25-34	12	3	19	1	13	0	8	0	8	6
35-44	10	1	14	1	14	2	11	3	18	2
45-54	8	2	7	0	5	2	8	0	7	1
55-64	4	3	6	0	5	0	1	0	5	1
65+	1	2	2	0	2	0	4	0	2	0
Total	**36**	**12**	**48**	**2**	**42**	**4**	**34**	**4**	**41**	**10**

^Excluded tourists and foreigners seeking medical treatment in Singapore.

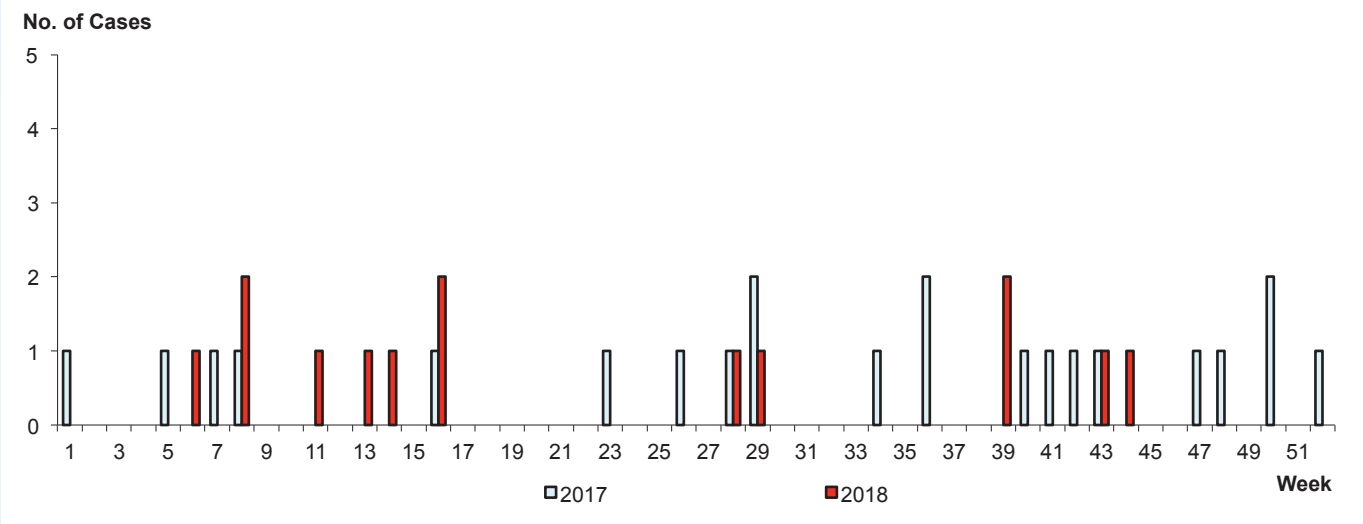
A total of 18,930 blood samples were screened at the KK Women's and Children's Hospital for HBsAg and HBeAg in 2018. Of these, 282 (1.5%) were HBsAg positive and 77 (0.4%) were HBeAg positive.

HEPATITIS C

Hepatitis C virus (HCV) is an enveloped RNA virus in the *Flaviviridae* family. HCV infection may result in acute hepatitis, but may also be asymptomatic. A significant proportion of patients develop chronic hepatitis which can result in chronic liver diseases such as cirrhosis and liver cancer. Patients with chronic hepatitis C are infective, and HCV is most efficiently transmitted by direct percutaneous exposure to infected blood or intravenous drug use. Currently, treatment using direct-acting antivirals (DAAs) is effective but costly.

A total of 14 cases of acute hepatitis C were reported in 2018, compared to 22 cases reported in 2017 (Figure 5.2).

Figure 5.2
Weekly distribution of reported acute hepatitis C cases, 2017-2018



The resident incidence rate was highest in the 35-44 years age group and an overall male to female ratio among cases was 5:1 (Table 5.4). Among the three major ethnic groups, Malays had the highest incidence rate (Table 5.5). All were local cases (Table 5.6).

Table 5.4
Age-gender distribution and age-specific resident incidence rate of reported acute hepatitis C cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	0	0	0	0	0
25-34	0	0	0	0	0
35-44	6	1	7	58.3	1.0
45-54	2	0	2	16.7	0.3
55-64	2	0	2	16.7	0.3
65+	0	1	1	8.3	0.2
Total	**10**	**2**	**12**	**100**	

^ Excluded two foreigners seeking medical treatment in Singapore
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 5.5
Ethnic-gender distribution and ethnic-specific incidence rate of reported acute hepatitis C cases^, 2018

	Male	Female	Cases	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	6	1	7	58.3	0.2
Malay	3	0	3	25.0	0.6
Indian	1	0	1	8.3	0.3
Others	0	0	0	0	0
Foreigners	0	1	1	8.3	0.1
Total	**10**	**2**	**12**	**100**	**0.2**

^ Excluded two foreigners seeking medical treatment in Singapore
* Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 5.6
Total number of notifications^ received for acute hepatitis C cases, 2014-2018

Age Group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	0	1	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0
15-24	0	0	4	0	2	0	2	0	0	0
25-34	0	0	7	0	2	1	3	0	0	0
35-44	1	0	5	0	6	0	5	0	7	0
45-54	2	1	12	0	4	0	7	0	2	0
55-64	1	0	15	0	5	0	3	0	2	0
65+	0	0	2	0	2	0	2	0	1	0
Total	**4**	**1**	**45**	**0**	**22**	**1**	**22**	**0**	**12**	**0**

^Excluded tourists and foreigners seeking medical treatment in Singapore

HUMAN IMMUNODEFICIENCY VIRUS INFECTION

Human immunodeficiency virus (HIV) belongs to the lentivirus group of the retrovirus family. HIV, the cause of the Acquired Immunodeficiency Syndrome (AIDS), remains a global cause for concern. According to the UNAIDS Global HIV and AIDS Update for 2018, there was an estimated 1.8 million new HIV infections and 36.9 million people living with HIV globally in 2017.

HIV can be transmitted from person to person through unprotected sexual intercourse, the use of contaminated needles including the sharing of needles among intravenous drug users, transfusion of infected blood or blood products, mucosal contact with infected body fluids, and the transplantation of HIV-infected tissues or organs. Mother-to-child or vertical transmission is the most common route of HIV infection in children.

AIDS is the advanced stage of HIV infection, where a person's immune system is severely damaged and vulnerable to opportunistic infections. Previously, individuals infected with HIV could progress to AIDS in eight to ten years. However, since the introduction of Highly Active Anti-Retroviral Therapy (HAART) in the mid-1990s, the life expectancy of a person living with HIV who is on treatment has greatly increased.

Singapore's multi-pronged National HIV/AIDS Control Programme comprises education of the general public and high-risk groups, protection of the national blood supply through screening of blood and blood products, management of cases and contact tracing, epidemiological surveillance, scaling up the prevention and control of sexually-transmitted infections (STIs), and legislation.

The National HIV/AIDS Policy Committee, which comprises representatives from seven ministries (Health; Defence; Home Affairs; Social and Family Development; Manpower; Education; Communications and Information), the National Centre for Infectious Diseases, the National Skin Centre, the Health Promotion Board, Action for AIDS and the Singapore National Employers Federation, provides guidance on all policy matters related to HIV infection/AIDS, including public health, legal, ethical, social and economic issues, and coordinates a broad-based multi-sectoral approach to the prevention and control of HIV infection/AIDS in Singapore.

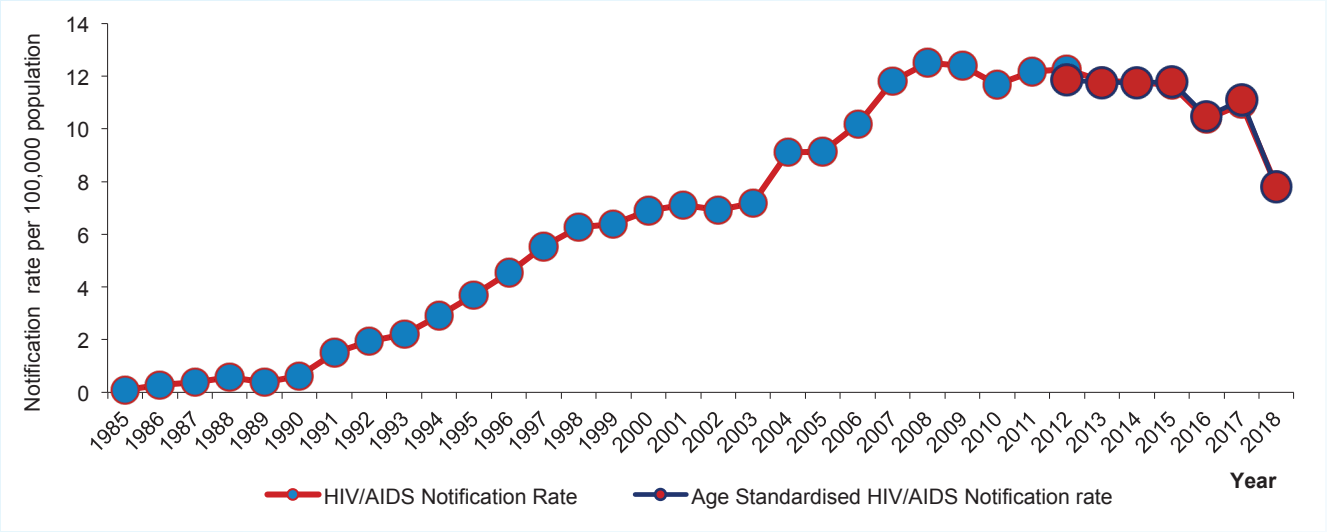
A total of 313 new HIV infections were reported among Singapore residents in 2018, compared to 434 cases in 2017 (Table 5.7). This brings the cumulative total number of HIV/AIDS infections among residents since the first case was diagnosed in 1985 to 8,295, of which 2,034 had died. 50% of the newly reported patients presented with late-stage[2] HIV infection. The notification rate of HIV/AIDS in 2018 was 7.8 per 100,000 population, compared to 10.9 per 100,000 population in 2017 (Table 5.7). In 2018, 74 deaths in HIV/AIDS patients were reported giving a mortality rate of 1.9 per 100,000 population.

[2] Defined by CD4+ cell count of less than 200 per cu mm OR AIDS-defining opportunistic infections OR both.

Table 5.7
Distribution of Singapore residents with HIV/AIDS by gender, 1985-2018

Year	Male	Female	Total	No. of cases per 100,000 population
1985	2	0	2	0.1
1986	6	1	7	0.3
1987	10	0	10	0.4
1988	15	0	15	0.6
1989	9	1	10	0.4
1990	17	0	17	0.6
1991	39	3	42	1.5
1992	49	6	55	1.9
1993	58	6	64	2.2
1994	76	10	86	2.9
1995	102	9	111	3.7
1996	123	16	139	4.5
1997	157	16	173	5.5
1998	167	32	199	6.3
1999	171	35	206	6.4
2000	193	33	226	6.9
2001	204	33	237	7.1
2002	206	28	234	6.9
2003	212	30	242	7.2
2004	290	21	311	9.1
2005	287	30	317	9.1
2006	327	32	359	10.2
2007	392	31	423	11.8
2008	426	30	456	12.5
2009	418	45	463	12.4
2010	403	38	441	11.7
2011	430	31	461	12.2
2012	437	32	469	12.3
2013	428	26	454	11.8
2014	422	34	456	11.8
2015	423	32	455	11.7
2016	380	28	408	10.4
2017	408	26	434	10.9
2018	290	23	313	7.8
Total	**7,577**	**718**	**8,295**	

Figure 5.3
Notification rate of HIV/AIDS in Singapore residents, 1985-2018



Distribution by age and gender

As in previous years, HIV/AIDS cases were predominantly male, with a male to female ratio of 13:1. In 2018, the highest notification rate was observed in the 50-59 years age group (Table 5.8).

Table 5.8
Age-gender distribution and age-specific notification rate of HIV/AIDS in Singapore residents, 2018

Age group	Male	Female	Total	%	Notification rate per 100,000 population		
					Male	Female	Total
0-14	0	0	0	0	0	0	0
15-19	4	0	4	1.3	3.4	0	1.8
20-29	53	4	57	18.2	19.4	1.5	10.4
30-39	60	4	64	20.5	21.6	1.3	10.9
40-49	67	5	72	23.0	22.7	1.6	11.8
50-59	69	5	74	23.6	22.5	1.6	12.1
60 & above	37	5	42	13.4	9.6	1.2	5.1
Total	**290**	**23**	**313**	**100**			
Crude rate					14.8	1.1	7.8
Age-standardised rate					14.9	1.1	7.8

Rates are based on 2018 estimated mid-year population and standardised population for age-standardised rate using 2010 mid-year population.
(Source: Singapore Department of Statistics)

Ethnic distribution

Among the three major ethnic groups, Malays had the highest HIV notification rate at 11.0 per 100,000 population, followed by Indians (Table 5.9).

Table 5.9
Ethnic-gender distribution and ethnic-specific notification rate of HIV/AIDS in Singapore residents, 2018

Ethnic group	Male	Female	Total	%	Notification rate per 100,000 population		
					Male	Female	Total
Chinese	199	10	209	66.8	13.8	0.7	7.0
Malay	52	7	59	18.8	19.5	2.6	11.0
Indian	26	3	29	9.3	14.1	1.7	8.0
Others	13	3	16	5.1	21.9	4.3	12.4
Total	**290**	**23**	**313**	**100**	**14.8**	**1.1**	**7.8**

Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Mode of HIV/AIDS transmission

The main mode of HIV transmission was through sexual intercourse, representing 95.2% of cases in 2018 (Table 5.10). Heterosexual transmission accounted for 43.1% of all cases in 2018, while homosexual and bisexual transmission accounted for 52.1%.

Table 5.10
Distribution of Singapore residents with HIV/AIDS by mode of transmission, 2018

Mode of transmission	No.	%
Sexual Transmission		
Heterosexual	135	43.1
Homosexual	131	41.9
Bisexual	32	10.2
Intravenous drug use	1	0.3
Blood Transfusion	0	0
Renal Transplant overseas	0	0
Perinatal (mother to child)	0	0
Uncertain/Others	14	4.5
Total	**313**	**100**

Mode of detection

About 56.5% of the newly reported cases were detected by HIV tests done in the course of medical care provisioning. Another 21.7% were detected during routine programmatic HIV screening while 14.1% were detected as a result of voluntary HIV screening. The rest were detected through other types of screening.

Table 5.11
Distribution of Singapore residents with HIV/AIDS by mode of detection, 2018

Mode of detection	No.	%
Medical care*	177	56.5
Routine programmatic HIV screening^	68	21.7
Voluntary	44	14.1
Others/Uncertain	24	7.7
Total	**313**	**100**

*Included cases that presented with HIV-specific symptoms and cases with non-HIV related medical conditions.
^Included screening programmes for individuals with sexually transmitted infections, hospital inpatients and those identified through contact tracing.

Contact tracing and notification

In 2018, a total of 301 HIV cases (excluding 12 who had died or were overseas) were identified for contact tracing. Of these, 277 cases were interviewed. The remaining cases were hospitalised, or pending interview (as at 31 December 2018).

A total of 66 spouses (excluding spouses who had died, were divorced or overseas) were identified for notification under the spousal notification programme. Of these, 64 were notified. The remaining spouses were not notified as it was assessed that there was no ongoing risk of transmission.

A total of 208 sexual contacts were reported during contact tracing interviews with cases. Of these, 121 contacts were contacted, notified of their exposure to HIV, and advised to undergo testing. 102 of the notified contacts reported that they had been tested for HIV, with four of them testing positive.

HIV surveillance programmes

Table 5.12 shows the overall results for three HIV surveillance programmes in Singapore. The proportion of cases tested positive for HIV within each programme has declined or remained stable over the last five years. In 2018, the prevalence of HIV positivity among individuals tested at anonymous test sites was the highest, at 0.7%, followed by those screened by the inpatient opt-out testing and antenatal screening programmes, at 0.3% and 0.06% respectively.

Table 5.12
Results for HIV surveillance programmes, 2014-2018

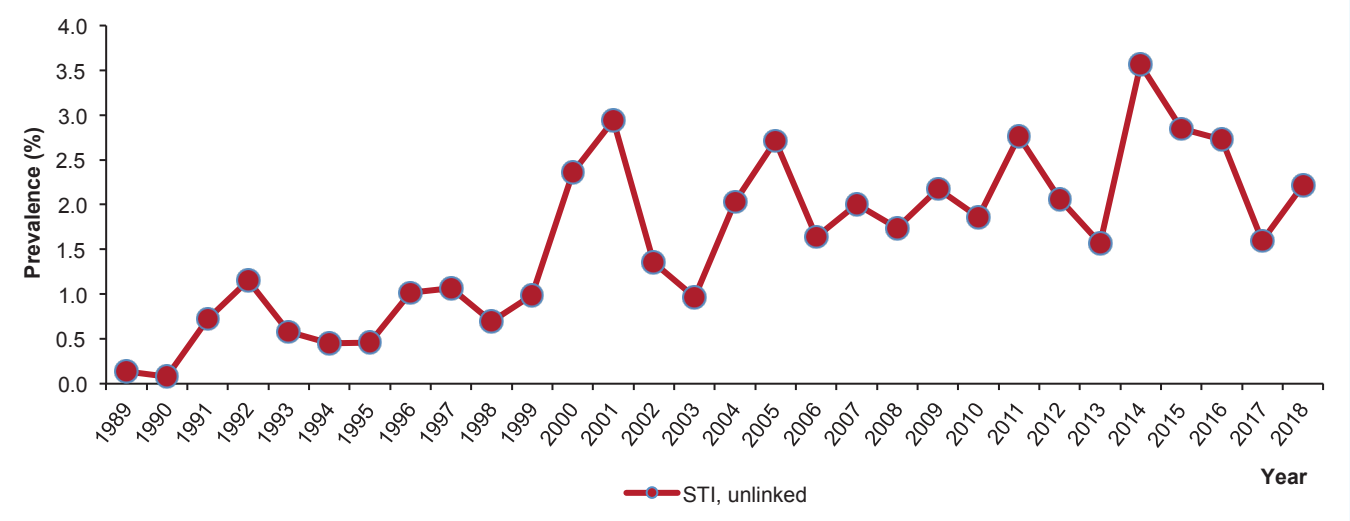
Programme		2014	2015	2016	2017	2018
Anonymous test sites	Total number of tests done	15,950	15,641	17,781	17,363	16,539
	Number tested positive	202	223	179	182	112
	Percentage tested positive (%)	1.3	1.4	1.0	1.1	0.7
Inpatient opt-out testing	Total number of tests done	30,834	30,123	28,684	28,724	18,033
	Number tested positive	58	49	49	58	60
	Prevalence (%)	0.2	0.2	0.2	0.2	0.3
Antenatal screening	Total number of tests done*	41,580	40,305	38,855	36,638	35,649
	Number tested positive	20	19	10	14	22
	Prevalence (%)	0.1	0.1	0	0	0.1

* Figures revised in 2018

Unlinked anonymous HIV seroprevalence surveillance

One sentinel population's HIV seroprevalence was monitored through unlinked anonymous testing. These are patients with sexually transmitted infections (STIs) who attended at the Department of STI Control (DSC) clinic. The overall HIV seroprevalence in 2018 (0.77%) among STI attendees at the clinic remained similar to 2017 (0.76%). The HIV seroprevlance of previously undiagnosed HIV among unlinked anonymouse surveillance increased from 1.59% in 2017 to 2.22% in 2018 (Figure 5.4).

Figure 5.4
Unlinked anonymous HIV seroprevalence, 1989-2018



HIV molecular surveillance

In 2018, 16.9% of newly-diagnosed, treatment-naïve HIV-positive individuals were classified as recent infections using an in vitro quantitative enzyme immunoassay carried out by National Public Health Laboratory (NPHL). The proportion of recent infections declined from 23.8% in 2017 to 16.9% in 2018 (Table 5.13). Virological surveillance of HIV strains among these recently-infected individuals revealed that the predominant circulating subtype was CRF01_AE (63.6%), followed by subtype B (27.3%). The overall prevalence of transmitted drug resistance (TDR) to any antiretroviral (ARV) class was 3.8%. TDR to nucleoside reverse transcriptase inhibitors (NRTIs), non-nucleoside reverse transcriptase inhibitors (NNRTIs) and protease inhibitors (PIs) were 0.8%, 2.3% and 0.8% respectively. The most common TDR mutation to NNRTIs observed in this cohort was K103N.

Table 5.13
Results for HIV molecular surveillance programme, 2014-2018

HIV molecular surveillance	**2014**	**2015**	**2016**	**2017**	**2018**
Total number of samples tested	118	116	245	160	130
Recent infections (%)	17.8	22.4	20.4	23.8	16.9
Circulating subtypes (%)					
CRF01_AE	60.0	61.5	64.0	52.6	63.6
Subtype B	40.0	34.6	24.0	34.2	27.3
Transmitted Drug Resistance					
Any drug class (%)	3.4	7.0	3.7	3.1	3.8
NRTI (%)	1.7	0.9	0.8	1.3	0.8
NNRTI (%)	1.7	2.6	3.3	1.9	2.3
PI (%)	0	3.5	0.8	1.3	0.8

SEXUALLY TRANSMITTED INFECTIONS

Sexually transmitted infections (STIs) are infections caused by different pathogens (e.g. bacteria, viruses, parasites, fungi) which are spread from person to person primarily through sexual contact. The common and important STIs are caused by *Treponema pallidum* (syphilis), *Neisseria gonorrhoeae*, *Chlamydia trachomatis* (infection of the urethra, cervix, pharynx and rectum), herpes simplex virus – types 1 and 2 (anogenital herpes), human papillomavirus (anogenital warts), *Trichomonas vaginalis* (infection of the urethra and vagina) and human immunodeficiency virus (HIV).

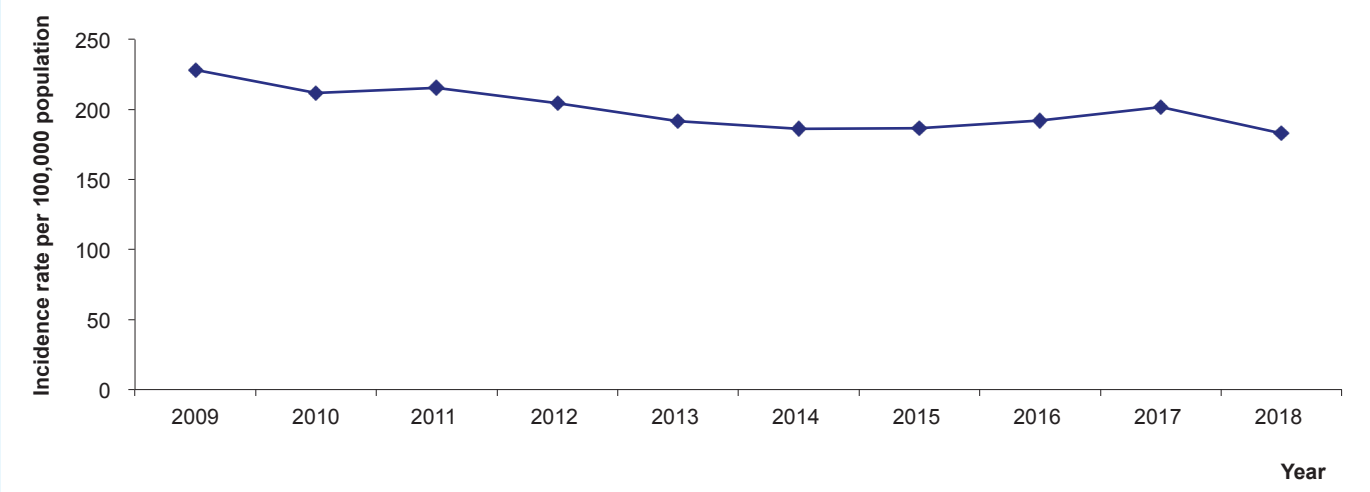
The diagnosis of an STI is a “sentinel” event which indicates unprotected sexual activity and therefore, patients presenting with one STI are at increased risk of acquiring other STIs. The presence of STIs can increase the risk of acquisition of HIV infection and also promote its transmission. Sexually transmissible pathogens are also implicated in other reproductive system problems such as pelvic inflammatory disease (PID), infertility and ectopic pregnancy.

The DSC Clinic of the National Skin Centre (NSC) is a public clinic for the diagnosis, treatment and control of STIs in Singapore. The DSC runs the National STI Control Programme in Singapore, and its activities include health and public education on STI/HIV, clinic services, disease detection, patient management and research.

Disease trend

The overall incidence for STIs decreased from 201.6 per 100,000 population in 2017 to 183 per 100,000 population in 2018. (Figure 5.5). The three main bacterial STIs notified in 2018 were chlamydia, gonorrhoea and syphilis.

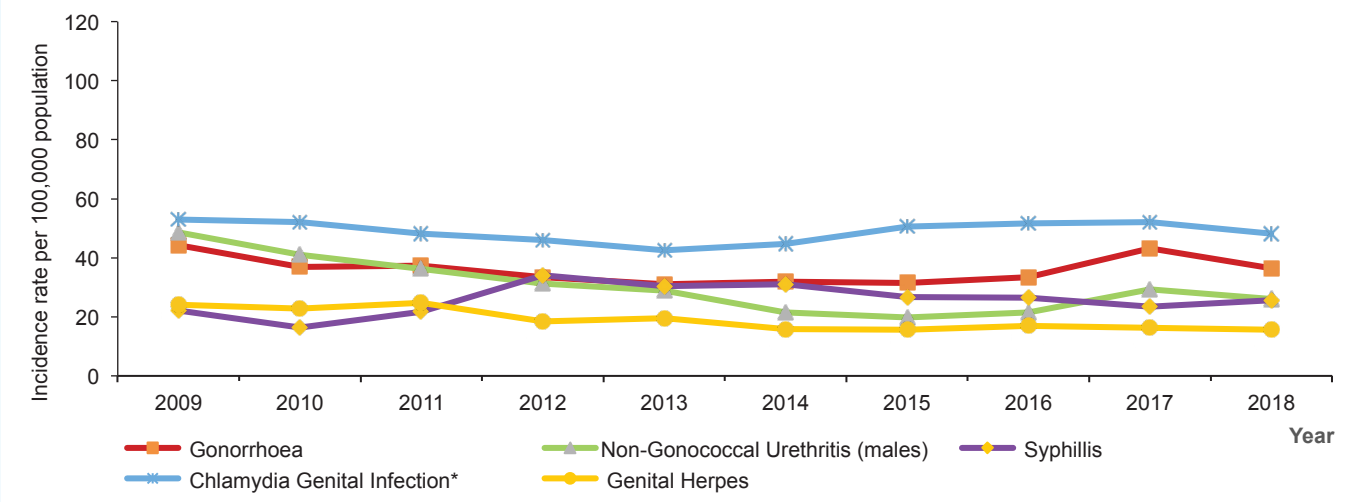
Figure 5.5
Incidence rate of STIs, 2009-2018



Legally notifiable STIs

STIs which are legally notifiable under the Infectious Diseases Act (IDA) comprise gonorrhoea, non-gonococcal urethritis, syphilis, chlamydia and genital herpes. Since 19 December 2008, the IDA requires medical practitioners to notify all cases of chlamydia genital infection to NSC within 72 hours of diagnosis. The incidence rates of individual legally notifiable STIs are shown in Figure 5.6.

Figure 5.6
Incidence rate of legally notifiable STIs*, 2009-2018



* Monitoring for chlamydia genital infection started in 1999, and it was made legally notifiable since 19 December 2008.

Distribution by STIs and gender

Among the five legally notifiable STIs, the overall incidence of chlamydia was the highest, followed by gonorrhoea and syphilis. The incidence of legally notifiable STIs was higher among males than females (Table 5.14).

Table 5.14
Distribution of incidence rate by STIs and gender, 2018

STIs	Incidence rate per 100,000 population*		
	Male	Female	Total
Legally Notifiable STIs			
Chlamydia	59.8	36.1	48.2
Gonorrhoea	59.7	11.8	36.4
Non-Gonococcal Urethritis (NGU)	26.1	NA	
Syphilis	38.1	12.4	25.6
Genital herpes	19.3	11.6	15.6
Other STIs			
Vaginal discharge^	NA	11.2	
Candidiasis	4.2	15.2	9.5
Genital warts	27.2	5.4	16.6
Mucopurulent cervicitis (MPC)	NA	14.4	
Chancroid	0	0	0
Others	5.9	4.5	5.2
Total	**240.3**	**122.5**	**183**

*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)
^Trichomoniasis, bacterial vaginosis.

Ethnic distribution

Among the three major ethnic groups, Malays had the highest incidence rate at 183.1 per 100,000 population, followed by Chinese and Indians (Table 5.15).

Table 5.15
Ethnic-gender distribution and ethnic-specific incidence rate of STIs among Singapore residents, 2018

Ethnic group	Male	Female	Total	%	Incidence rate per 100,000 population*		
					Male	Female	Total
Chinese	3,857	1,580	5,437	72.0	266.9	103.7	183.1
Malay	595	357	952	12.6	223.3	132.5	177.7
Indian	356	115	471	6.2	193.0	65.3	130.6
Others	492	203	695	9.2	827.2	293.5	540.2
Total	**5,300**	**2,255**	**7,555**	**100**	**271.0**	**110.6**	**189.1**

*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Chlamydia

Chlamydia is the most common cause of NGU. The incidence of chlamydia has shown a slight decrease in both males and females in 2018 (59.8 and 36.1 per 100,000 population respectively), compared to 2017 (64.2 and 39.0 per 100,000 population respectively) (Table 5.14).

Syphilis

The incidence rate of syphilis was 25.6 per 100,000 population in 2018 compared to 23.6 in 2017. In 2018, the incidence rate of infectious syphilis was 6.4 per 100,000 population compared to 6.6 in 2017. There was one case of congenital syphilis in 2018 involving an adult who reported having contracted syphilis during infancy.

Gonorrhoea

The incidence rate of gonorrhoea was 36.4 per 100,000 population in 2018 compared to 43.2 in 2017. There were no cases of gonococcal ophthalmia neonatorum reported in 2018.

The percentage of gonorrhoea cultures with decreased susceptibility to ceftriaxone was 4.8% in 2018 compared to 5.4% in 2017 (Table 5.16).

The percentage of *Neisseria gonorrhoeae* cultures resistant to ciprofloxacin was 83.7% in 2018 compared to 87.5% in 2017 (Table 5.17).

Table 5.16
Susceptibility of gonorrhoea cultures to ceftriaxone, 2009-2018*

Year	No. of gonorrhoea cultures	Decreased Susceptibility (%)	Susceptible (%)
2009	160	0	100
2010	160	2.5	97.5
2011	160	6.9	93.1
2012	148	14.2	85.8
2013	160	14.4	85.6
2014	160	9.4	90.6
2015	160	7.5	92.5
2016	160	6.2	93.8
2017	239	5.4	94.6
2018	294	5.1	94.9

* Prior to 2017, the percentage of penicillinase-producing *Neisseria gonorrhoeae* (PPNG) detected among gonorrhoea positive cultures screened was reported. As penicillin is no longer used in the treatment of gonorrhoea with effect from 2017, susceptibility of gonorrhoea to ceftriaxone is reported instead.
# Included one isolate resistant to ceftriaxone.

Table 5.17
Gonorrhoea cultures screened for resistance to ciprofloxacin, 2009-2018

Year	No. of cultures	Ciprofloxacin resistant cases	
		No.	%
2009	160	127	79.4
2010	160	117	73.1
2011	160	131	81.9
2012	158	117	74.1
2013	160	133	83.1
2014	160	143	89.4
2015	160	138	86.3
2016	160	131	81.9
2017	239	209	87.5
2018	294	246	83.7

CHAPTER 6

OTHER DISEASES

Tuberculosis is one of the top ten causes of death worldwide, and most often affects the lungs while leprosy is a chronic bacterial disease. Both diseases are treatable. Besides people and animals, sources of infection are present in the environment, and promotion of better environmental management or infection control practices in healthcare settings can prevent the spread of diseases. Singapore also keeps a lookout for novel, emerging diseases through the Severe Illness and Death from Possibly Infectious Causes (SIDPIC) programme.

LEGIONELLOSIS

Legionellosis is an acute bacterial disease caused by the bacterium *Legionella pneumophila*. It has two recognised distinct clinical and epidemiological manifestations: Legionnaires' disease and Pontiac fever. Both conditions are characterised by fever, chills, anorexia, malaise, myalgia and headache, but only Legionniares' disease is associated with pneumonia. The chest X-ray for a patient with Legionnaires' disease may reveal patchy or focal areas of consolidation. The mode of transmission is airborne and includes aspiration of aerosolised water containing the bacteria.

A total of 22 cases of laboratory confirmed legionellosis were reported in 2018, compared with 19 cases in 2017 (Figure 6.1). 19 of these 22 cases were local residents, while the remaining three included one tourist and two foreigners seeking medical treatment in Singapore. 20 cases had confirmed Legionnaires' disease, one case had confirmed Pontiac fever and one case had presumptive Pontiac fever (Table 6.1). 10 of the 19 resident cases had acquired the infection overseas (Table 6.2).

Figure 6.1
Weekly distribution of reported legionellosis cases, 2017-2018

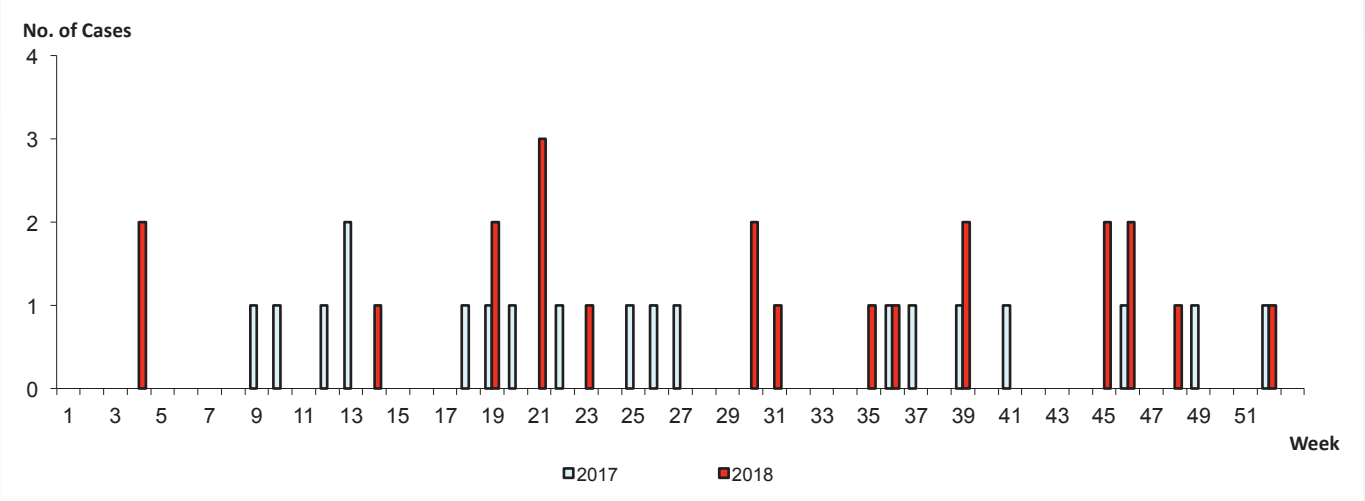


Table 6.1
Classification of reported legionellosis cases, 2018

	Pontiac fever	Legionnaires' disease	Total
Confirmed cases	1	20	21
Presumptive cases	1	0	1
Total	**2**	**20**	**22**

Table 6.2
Total number of notifications* received for legionellosis cases, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	0	0	0	0	0	0	0
5-9	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0
15-24	0	0	0	0	0	0	0	0	0	0
25-34	1	0	0	0	0	0	0	0	0	0
35-44	2	1	0	0	1	0	2	0	0	1
45-54	1	1	2	0	1	0	2	0	1	1
55-64	4	0	3	0	2	1	2	1	2	5
65+	19	2	11	1	4	0	7	2	6	3
Total	**27**	**4**	**16**	**1**	**8**	**1**	**13**	**3**	**9**	**10**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

The resident incidence rate was highest among the 65+ years age group (Table 6.3). Among the three major ethnic groups, Malays had the highest incidence rate of 0.7 per 100,000 population (Table 6.4). Various occupational groups were also affected (Table 6.5).

Table 6.3
Age-gender distribution and age-specific resident incidence rate of reported legionellosis cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	0	0	0	0	0
25-34	0	0	0	0	0
35-44	1	0	1	5.3	0.2
45-54	2	0	2	10.5	0.3
55-64	6	1	7	36.8	1.2
65+	7	2	9	47.4	1.6
Total	**16**	**3**	**19**	**100**	

^Excluded two foreigners seeking medical treatment in Singapore and one tourist.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 6.4
Ethnic-gender distribution and ethnic-specific incidence rate of legionellosis cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	11	2	13	68.4	0.4
Malay	3	1	4	21.1	0.7
Indian	0	0	0	0	0
Others	0	0	0	0	0
Foreigners	2	0	2	10.5	0.1
Total	**16**	**3**	**19**	**100**	**0.3**

^Excluded one tourist and two foreigners seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 6.5
Occupations* of reported resident legionellosis cases, 2018

Occupation	No. of cases (n=15^)
Cleaners	2
Company Directors	1
Drivers - Taxi/Bus/MRT & deliveryman	1
Health Care Workers - doctors/nurses/other HCW	1
Housewife	1
Policemen/firemen/security guard	1
Retiree	5
Supervisors & general foremen	1
Technicians/asst ngineers	1
Unemployed	1

*According to Singapore Standard Occupational Classification 2000 (Department of Statistics).
^ Occupation of four cases were unknown.

Key presenting symptoms of the 19 resident legionellosis cases included fever, cough and shortness of breath (Table 6.6).

Table 6.6
Clinical presentation of reported legionellosis cases^, 2018

Clinical presentation	No. of cases* (n=19)
Fever (with/without chills and rigors)	15
Respiratory symptoms	
Cough (productive and non-productive)	13
Shortness of breath	9
Other signs and symptoms	
Chills	4
Myalgia	0
Giddiness	5
Abdominal pain	4
Generalised weakness	1
Vomiting	1

* Cases might have one or more clinical presentations.
^ Excluded one tourist and two foreigners seeking medical treatment in Singapore.

Five (26.3%) of the cases had known risk factors for legionellosis (Table 6.7). There was no legionellosis death reported.

Table 6.7
Number of cases with known risk factors for legionellosis^, 2018

Risk Factors	No of Cases
Diabetes mellitus	3
Chronic lung disease (e.g. asthma, chronic obstructive pulmonary disease)	2
Immunosupression (e.g. corticosteroid therapy, organ transplantation)	0
Smoking	0

*Cases might have one or more concurrent medical conditions.
^Excluded one tourist and two foreigners seeking medical treatment in Singapore

LEPROSY

Leprosy is a chronic bacterial disease of the skin, peripheral nerves and the upper airway (in lepromatous patients) by *Mycobacterium leprae*. The manifestations of the disease vary in a continuous spectrum between the two polar forms, lepromatous and tuberculoid leprosy. It can present as hypopigmented patches with diminished sensation, multiple raised plaques, thickened nerves or neuritis. Diagnosis can be made through clinical features, a slit skin smear or skin biopsy for histological examination.

In the past, leprosy was regarded as a highly contagious, mutilating and incurable disease leading to social stigma associated with the disease and the people afflicted with it. Before effective treatment for leprosy was available, patients were segregated in leprosariums to prevent the spread of leprosy to the community. Modern treatment for leprosy was introduced in 1941 when dapsone and its derivatives were used. With effective chemotherapy, leprosy is curable today and patients are now treated in the general health services alongside other diseases. Currently, the Cutaneous Infections Unit of the National Skin Centre undertakes the treatment of leprosy based on the WHO guidelines for therapy.

The distribution of leprosy notifications among Singapore residents and non-residents from 2010 to 2018 is shown in Table 6.8.

Table 6.8
Leprosy notifications among Singapore residents and non-residents, 2010-2018

Year	No. of cases		
	Resident (%)	Non-resident (%)	Total
2010	4 (30.8)	9 (69.2)	13
2011	5 (31.2)	11 (68.8)	16
2012	5 (33.3)	10 (66.7)	15
2013	3 (25.0)	9 (75.0)	12
2014	1 (16.7)	5 (83.3)	6
2015	1 (33.3)	2 (66.7)	3
2016	2 (28.6)	5 (71.4)	7
2017	0 (0)	6 (100)	6
2018	2 (33.3)	4 (66.7)	6

Leprosy in Singapore residents

The incidence rate of leprosy among Singapore residents has declined over the past five decades, from 21.3 per 100,000 population in 1960 to 0 per 100,000 population in 2018. In 2018, 2 male Singapore residents with leprosy were notified (Table 6.9). Leprosy patients are classified into multibacillary or paucibacillary types. (Table 6.10).

Table 6.9
Distribution of leprosy notifications among Singapore residents by gender, 2010-2018

Year	No. of cases		
	Male	Female	Total
2010	3	1	4
2011	2	3	5
2012	4	1	5
2013	1	2	3
2014	1	0	1
2015	0	1	1
2016	2	0	2
2017	0	0	0
2018	2	0	2

Table 6.10
Distribution of leprosy notifications among Singapore residents by type of infection, 2010-2018

Year	No. of cases		
	Multibacillary	Paucibacillary	Total
2010	2	2	4
2011	3	2	5
2012	5	0	5
2013	2	1	3
2014	1	0	1
2015	1	0	1
2016	1	1	2
2017	0	0	0
2018	1	1	2

Leprosy in non-residents

The contribution of non-residents to the total number of cases has fluctuated over the years. In 2018, there were four non-residents (two males and two females) notified with leprosy (Table 6.11). In 2018, there was no case of paucibacilliary leprosy among non-residents (Table 6.12).

Table 6.11
Distribution of leprosy notifications among non-residents by gender, 2010-2018

Year	Male	Female	Total
2010	5	4	9
2011	7	4	11
2012	7	3	10
2013	6	3	9
2014	2	3	5
2015	1	1	2
2016	4	1	5
2017	5	1	6
2018	2	2	4

Table 6.12
Distribution of leprosy notifications among non-residents by type of infection, 2010-2018

Year	Multibacillary	Paucibacillary	Unknown	Total
2010	4	5	0	9
2011	9	2	0	11
2012	6	4	0	10
2013	6	2	1	9
2014	2	2	1	5
2015	0	2	0	2
2016	2	3	0	5
2017	4	1	1	6
2018	3	0	1	4

MELIOIDOSIS

Melioidosis is a bacterial infection with a wide spectrum of clinical manifestations, ranging from pulmonary consolidation to localised cutaneous or visceral abscesses, and necrotising pneumonia with or without septicaemia. The infectious agent is *Burkholderia pseudomallei*. The mode of transmission is by contact with contaminated soil or water through overt or inapparent skin lesions. It can also be transmitted by aspiration or ingestion of contaminated water or inhalation of dust from contaminated soil.

There were 34 cases of laboratory confirmed melioidosis in 2018, compared with 52 cases in 2017 (Figure 6.2). 32 of these cases were classified as indigenous cases and two were imported cases. The latter involved one Singapore resident, and one foreigner seeking medical treatment in Singapore (Table 6.13).

Figure 6.2
Weekly distribution of reported melioidosis cases, 2017-2018

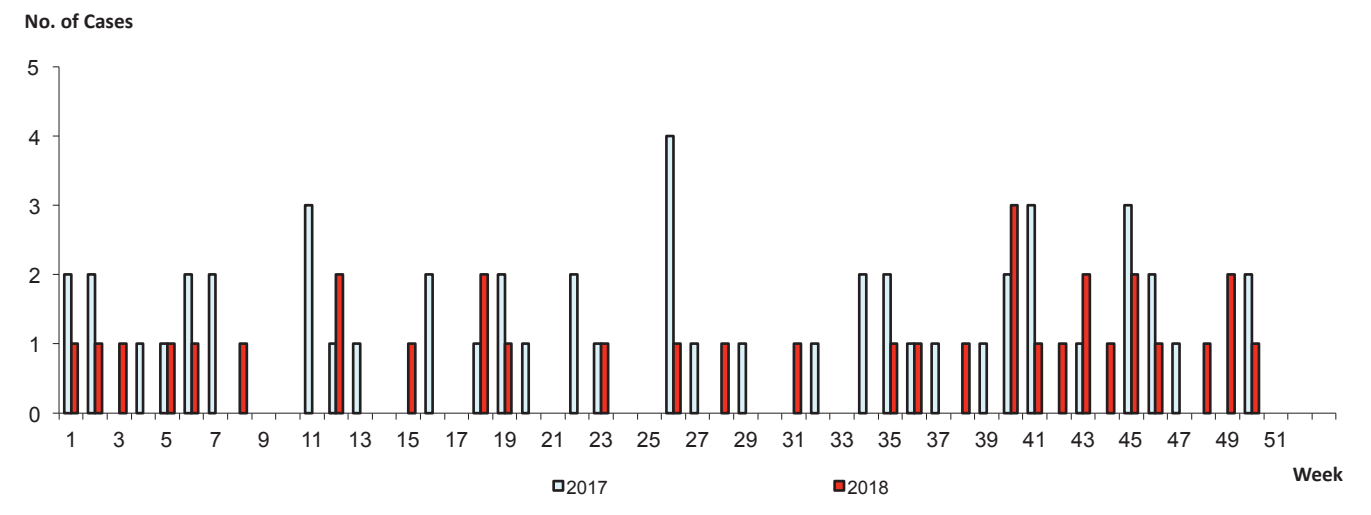


Table 6.13
Total number of notifications* received for melioidosis cases, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	0	0	0	0	0	0	0
5-9	0	0	0	0	0	0	0	0	1	0
10-14	2	0	1	0	1	0	1	0	1	0
15-24	2	0	3	0	2	0	2	0	2	0
25-34	2	0	1	0	1	0	2	0	3	0
35-44	8	1	3	1	7	0	3	0	2	0
45-54	8	0	9	2	9	0	13	0	7	0
55-64	2	0	11	1	18	2	7	1	9	1
65+	8	0	9	0	15	1	19	0	7	0
Total	**32**	**1**	**37**	**4**	**53**	**3**	**47**	**1**	**32**	**1**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

The resident incidence rate was highest among the 55 - 64 years age group (Table 6.14). Among the three major ethnic groups, Malays had the highest incidence (Table 6.15).

Table 6.14
Age-gender distribution and age-specific resident incidence rate of melioidosis cases^, 2018

Age group	Number of notifications				Incidence rate per 100,000 resident population*
	Male	Female	Total	%	
0-4	0	1	1	3.0	0.5
5-14	1	0	1	3.0	0.2
15-24	1	1	2	6.1	0.4
25-34	2	1	3	9.1	0.5
35-44	2	0	2	6.1	0.3
45-54	7	0	7	21.2	1.1
55-64	9	1	10	30.3	1.7
65+	7	0	7	21.2	1.3
Total	**29**	**4**	**33**	**100**	

^Excluded one foreigner seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 6.15
Ethnic distribution and ethnic-specific incidence rate of melioidosis cases^, 2018

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	15	2	17	51.5	0.6
Malay	10	0	10	30.3	1.9
Indian	1	1	2	6.1	0.6
Others	1	0	1	3.0	0.8
Foreigners	2	1	3	9.1	0.2
Total	**29**	**4**	**33**	**100**	**0.6**

^ Excluded one foreigner seeking medical treatment in Singapore.
*Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Burkholderia pseudomallei were isolated from blood cultures in 16 of the 34 cases (Table 6.16). The predominant signs and symptoms of melioidosis were fever and abdominal pain (Table 6.17). 48.5% of the cases presented with localised or multiple abscesses. Those who presented with bacteraemia comprised 51.5% of the cases in 2018 (Table 6.18).

Table 6.16
Types of laboratory sample of melioidosis cases^, 2018

Types of laboratory sample	No. of cases*	%
Blood	16	45.8
Bronchial alveolar lavage	0	0
Endotracheal tube aspirate	0	0
Pleural Fluid	0	0
Pus	4	11.4
Sputum	2	5.7
Swabs	4	11.4
Urine	2	5.7
Others	7	20.0
Total	**35**	**100**

^ Excluded one foreigner seeking medical treatment in Singapore.
* Cases might have one or more laboratory samples taken

Table 6.17
Clinical presentation of reported melioidosis cases^, 2018

Clinical presentation	No. of cases* (n=33)
Fever (with/without chills and rigors)	25
Respiratory symptoms	
Cough (productive and non-productive)	8
Runny nose	1
Chest pain	2
Other signs and symptoms	
Abdominal pain/discomfort/epigastric pain	11
Vomiting	6
Diarrhoea	4
Abscesses (localised, systemic)	16

^ Excluded one foreigner seeking medical treatment in Singapore.
*Cases may have one or more clinical presentations.

Table 6.18
Cases of melioidosis presenting with bacteraemia and abscesses, 2014 – 2018

Year	Cases	Bacteraemia		Abscesses			
		No.	(%)	All Abscesses		Cutaneous	
				No.	%	No.	%
2014	32	15	46.9	11	34.4	2	6.3
2015	41	22	53.7	19	46.3	9	22.0
2016	56	37	66.1	19	33.9	12	21.4
2017	48	34	70.8	14	29.2	10	20.8
2018^	33	17	51.5	16	48.5	12	36.4

^ Excluded one foreigner seeking medical treatment in Singapore.

18 (54.5%) of the cases had known risk factors for melioidosis (Table 6.19). One melioidosis-related death was reported in 2018.

Table 6.19
Number of cases with known risk factors for melioidosis^, 2018

Risk factors	No of cases*
Diabetes mellitus	13
Chronic lung disease (e.g. asthma, chronic obstructive pulmonary disease)	2
Chronic renal disease (e.g. chronic renal failure, kidney disease)	3

*Cases may have one or more concurrent medical conditions.
^ Excluded one foreigner seeking medical treatment in Singapore.

TUBERCULOSIS

Tuberculosis (TB) is a mycobacterial disease that is a major cause of death and disability in many parts of the world especially in developing countries. Initial tuberculosis infection is typically asymptomatic and is known as latent TB infection (LTBI). About 10% of immunocompetent adults with LTBI will eventually progress to active disease, and half of them will do so in the first two years following infection. The risk of progression to active disease is increased in immunosuppressed persons and in children under five years of age.

The National TB Control Programme was established in the late 1950s with the setting up of the TB Control Unit and a National TB registry. The programme was enhanced with the launch of the Singapore TB Elimination Programme (STEP) in 1997. The main aim of STEP is to eliminate TB in Singapore by detecting, diagnosing and treating all

infectious TB cases, identifying and treating infected TB contacts, and preventing the emergence of multidrug-resistant TB (MDR-TB).

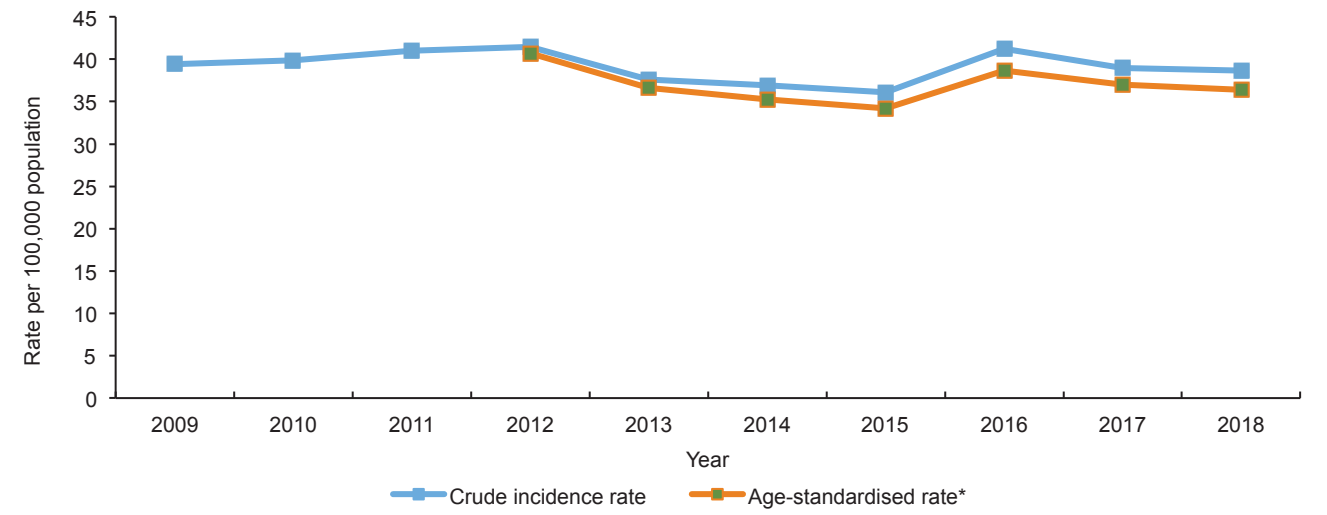
Incidence and site of disease in total population (Singapore residents, long-staying foreigners)

A total of 3,094 cases of TB were notified in 2018. This comprised 1,547 new and 126 relapsed cases among Singapore residents (citizens and PRs) and 1,353 new and 68 relapsed cases among non-residents (long-and short-staying foreigners)

A total of 2,182 new cases of TB were notified among Singapore residents and long-staying foreigners in 2018. The crude incidence rate of TB was 38.7 per 100,000 population in 2018 (Figure 6.3), while the age-standardised incidence rate of TB was 36.4 per 100,000 population in 2018.

The majority (85.2%) of cases had pulmonary TB with or without extra-pulmonary involvement, while the remainder (14.8%) had exclusively extra-pulmonary TB (Table 6.20).

Figure 6.3
TB incidence rate in Singapore residents and long-staying foreigners, 2009-2018



*Age-standardised rate using 2010 mid-year Singapore resident population.
(Source: Singapore Department of Statistics)

Table 6.20
New TB cases by site of disease in Singapore residents and long-staying foreigners, 2009-2018

Year	New cases			Incidence rate per 100,000 population		
	Pulmonary[1]	Extra-pulmonary	Total	Pulmonary[1]	Extra-pulmonary	Total
2009	1,624	342	1,966	32.6	6.9	39.4
2010	1,727	301	2,028	34.0	5.9	39.9
2011	1,811	315	2,126	34.9	6.1	41.0
2012	1,897	306	2,203	35.7	5.8	41.5
2013	1,750	278	2,028	32.4	5.1	37.6
2014	1,705	313	2,018	31.2	5.7	36.9
2015	1,691	309	2,000	30.6	5.6	36.1
2016	1,930	380	2,310	34.4	6.8	41.2
2017	1,871	320	2,191	33.3	5.7	39.0
2018	1,858	324	2,182	33.0	5.7	38.7

[1] Pulmonary TB referred to TB of the lung parenchyma and included cases that had both pulmonary and extra-pulmonary TB.

In 2018, among the 1,858 new pulmonary TB cases in Singapore residents and long-staying foreigners, 1,808 (97.3%) had bacteriological tests done. The proportion found to have demonstrable bacillary disease was 61.9% (Table 6.21)

Table 6.21
Bacillary status of new pulmonary TB cases in Singapore residents and long-staying foreigners, 2009-2018

Year	No. tested for bacillary disease	% of notified pulmonary cases tested	No. of pulmonary cases with bacillary disease	% of pulmonary cases tested positive	Incidence rate per 100,000 population
2009	1,548	95.3	1,147	74.1	23.0
2010	1,652	95.7	1,169	70.8	23.0
2011	1,770	97.7	1,259	71.1	24.3
2012	1,816	95.7	1,213	66.8	22.8
2013	1,669	95.4	1,084	64.9	20.1
2014	1,621	95.1	1,033	63.7	18.9
2015	1,646	97.3	1,060	64.4	19.2
2016	1,831	94.9	1,187	64.8	21.1
2017	1,823	97.4	1,131	62.0	20.2
2018	1,808	97.3	1,119	61.9	19.8

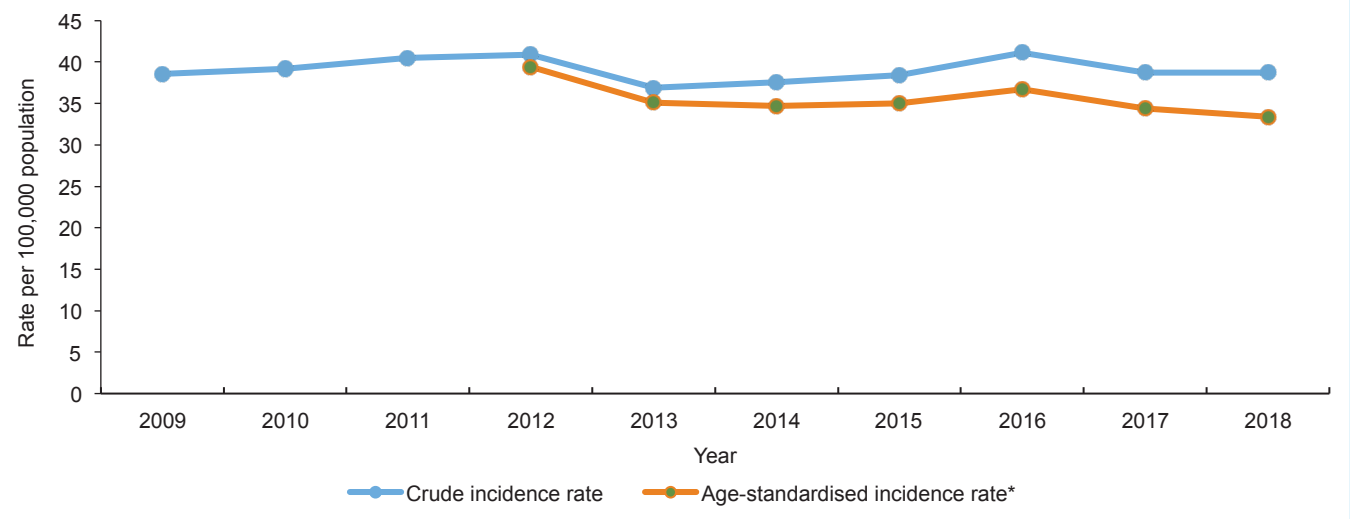
The table included only bacteriological investigations (smear and/or culture) done from three months before to two weeks after the date of notification or date of starting treatment, whichever earlier.

Incidence and site of disease in Singapore residents

From a historical perspective, the crude incidence rate of TB declined from 307 per 100,000 population in 1960 to 56.3 per 100,000 population in 1987. From 1987 to 1997, the crude incidence rate of new TB cases among Singapore residents stagnated around 50-55 per 100,000 population. Following enhanced TB control measures implemented by STEP, the crude incidence rate declined from 56.9 per 100,000 population in 1998 to a historical low of 35.1 per 100,000 population in 2007. However, in 2008, the crude incidence rate increased for the first time in ten years to 39.8 per 100,000 population. Between 2009 and 2015, the crude incidence rate stagnated at 38.6 to 40.9 per 100,000 population, before decreasing to 36.9 per 100,000 in 2013. Since then, the crude incidence rate has remained between 37 to 41 per 100,000 population. In 2018, the crude incidence rate of TB was 38.7 per 100,000 population which was same as in 2017. In contrast, the age-standardised incidence rate of TB was 33.4 per 100,000 population in 2018 (Figure 6.4).

Of the 1,547 new TB cases among Singapore residents notified in 2018, 1,309 (84.6%) of cases had pulmonary TB while 238 (15.4%) had exclusively extra-pulmonary TB. Of those with pulmonary TB, 199 (15.2%) had extra-pulmonary involvement while 1,110 (84.8%) did not have extra-pulmonary involvement (Table 6.22). Among cases with extra-pulmonary TB disease (437) in 2018, the most common site of extra-pulmonary TB was the pleura (154), followed by the lymphatic system (115).

Figure 6.4
TB incidence rate in Singapore residents, 2009-2018



Age-standardised rate using 2010 mid-year Singapore resident population.
(Source: Singapore Department of Statistics).

Table 6.22
Distribution of new TB cases by site of disease in Singapore residents, 2008-2018

Year	New Cases			Incidence rate per 100,000 population		
	Pulmonary[1]	Extra-pulmonary	Total	Pulmonary[1]	Extra-pulmonary	Total
2008	1,208	243	1,451	33.2	6.7	39.8
2009	1,205	237	1,442	32.3	6.3	38.6
2010	1,265	213	1,478	33.5	5.6	39.2
2011	1,309	224	1533	34.5	5.9	40.5
2012	1,359	201	1,560	35.6	5.3	40.9
2013	1,249	171	1,420	32.5	4.4	36.9
2014	1,220	234	1,454	31.5	6.0	37.6
2015	1,271	227	1,498	32.6	5.8	38.4
2016	1,353	264	1,617	34.4	6.7	41.1
2017	1,302	234	1,536	32.8	5.9	38.7
2018	1,309	238	1,547	32.8	6.0	38.7

[1] Pulmonary TB referred to TB of the lung parenchyma and included cases that had both pulmonary and extra-pulmonary TB.

Distribution by age and gender

As in previous years, TB in Singapore residents continues to be a disease of older males (Table 6.23). Of the 1,547 new cases notified in 2018, 1,114 (72.0%) were 50 years old and above, and 1,049 (67.8%) were males. In 2018, the TB incidence rate among males and females remained stable about 54 and 24 per 100,000 population, respectively.

Table 6.23
Age-gender distribution and incidence rate of TB in Singapore residents, 2018

Age group	Male	Female	Total	%	Incidence rate per 100,000 population*		
					Male	Female	Total
0-4	0	1	1	0.1	0	1.1	0.5
5-9	0	0	0	0	0	0	0
10-14	1	2	3	0.2	1.0	2.0	1.5
15-19	15	16	31	2.0	12.9	14.5	13.7
20-29	41	44	85	5.5	15.0	16.1	15.5
30-39	53	75	128	8.3	19.1	24.4	21.9
40-49	119	66	185	12.0	40.2	20.9	30.3
50-59	262	88	350	22.6	85.5	28.7	57.1
60-69	261	99	360	23.3	109.3	40.4	74.4
70-79	185	72	257	16.6	144.5	50.3	94.8
80+	112	35	147	9.5	274.6	53.0	137.5
Total	**1049**	**498**	**1547**	**100**	**53.6**	**24.4**	**38.7**

* Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics)

Ethnic distribution

Malays had the highest TB incidence among the three main ethnic groups. The incidence rate in Malays decreased from 64.3 per 100,000 population in 2017 to 59.2 per 100,000 population in 2018.The incidence rate among Chinese increased from 34.5 per 100,000 population in 2017 to 35.6 per 100,000 population in 2018, while that of Indian was stable at 28.6 per 100,000 population in 2018. (Table 6.24).

Table 6.24
Ethnic-gender distribution and ethnic-specific incidence rate of TB in Singapore residents, 2018

Ethnic group	Male	Female	Total	%	Incidence rate per 100,000 population
Chinese	750	306	1056	68.3	35.6
Malay	207	110	317	20.5	59.2
Indian	64	39	103	6.7	28.6
Others	28	43	71	4.6	55.2
Total	**1049**	**498**	**1547**	**100**	**38.7**

* Rates are based on 2018 estimated mid-year population.
(Source: Singapore Department of Statistics).

Clinical presentation and bacteriological status

In 2018, 1,289 (98.4%) of the 1,309 new pulmonary TB cases in Singapore residents had bacteriological tests done. The proportion found to have demonstrable bacillary disease was 69.3% (Table 6.25).

Table 6.25
Bacillary status of new pulmonary TB cases in Singapore residents, 2008-2018

Year	No. tested for bacillary disease	% of notified pulmonary cases tested	No. of pulmonary cases with bacillary disease	% of pulmonary cases tested positive	Incidence rate per 100,000 population
2008	1,177	97.4	952	80.9	26.1
2009	1,164	96.6	937	80.5	25.1
2010	1,236	97.7	951	76.9	25.2
2011	1,276	97.5	977	76.6	25.8
2012	1,321	97.2	981	74.3	25.7
2013	1,207	96.6	879	72.8	22.9
2014	1,183	97.0	858	72.5	22.2
2015	1,249	98.3	887	71.0	22.7
2016	1,304	96.3	931	71.3	23.7
2017	1,277	98.1	878	68.8	22.1
2018	1,289	98.4	894	69.3	22.4

Relapsed TB cases

In 2018, there were 126 relapsed TB cases notified among Singapore residents. This accounted for 7.5% of all cases (new & relapsed) among Singapore residents (Table 6.26).

Table 6.26
Age-gender distribution of relapsed TB cases in Singapore residents, 2014-2018

Age group	2014		2015		2016		2017		2018	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-9	0	0	0	0	0	0	0	0	0	0
10-19	1	0	0	0	0	0	1	1	0	0
20-29	3	0	0	3	0	3	1	3	1	1
30-39	5	7	3	2	3	5	2	2	3	5
40-49	10	3	7	6	8	3	8	6	5	3
50-59	22	5	30	9	16	8	21	2	23	12
60-69	29	7	18	7	38	8	34	8	23	2
70+	35	10	53	6	42	8	32	3	42	6
Sub Total	**105**	**32**	**111**	**33**	**107**	**35**	**99**	**25**	**97**	**29**
Total	**137**		**144**		**142**		**124**		**126**	

TB cases in Singapore residents by country of birth

Of the 1,547 new cases notified among residents in 2018, 1,259 (81.4%) were Singapore-born and 288 (18.6%) were foreign-born. Of the 126 relapsed TB cases notified among residents, 110 (87.3%) were Singapore-born and 16 (12.7%) were foreign-born. (Table 6.27).

Table 6.27
Distribution of TB cases by age group and country of birth in Singapore residents, 2017-2018

Age group	New cases				Relapsed cases			
	2017		2018		2017		2018	
	S'pore born	Foreign born	S'pore born	Foreign born	S'pore born	Foreign born	S'pore born	Foreign born
0-9	4	1	1	0	0	0	0	0
10-19	26	7	33	1	2	0	0	0
20-29	85	31	72	13	4	0	2	0
30-39	75	54	71	57	3	1	3	5
40-49	167	60	139	46	12	2	6	2
50-59	277	53	305	45	22	1	32	3
60-69	310	40	315	45	39	3	25	0
70+	259	87	323	81	27	8	42	6
Total	**1,203**	**333**	**1,259**	**288**	**109**	**15**	**110**	**16**

TB-HIV co-infection in residents

People living with HIV (PLHIV) are known to be particularly susceptible to TB, both from the reactivation of latent infection and from new infection with rapid progression to active disease. PLHIV are about 26 to 31 times more likely to develop TB disease than those who are HIV-negative worldwide. According to the 2018 WHO Global TB Report[3], people living with HIV accounted for 0.9 million (9.2%) of all new TB cases worldwide in 2017.

In 2018, there was a total of 1,673 notified cases of TB (both new and relapsed cases) among Singapore residents. Of these, 84.9% (1,421 cases) had a documented HIV status at the time of current TB diagnosis[4].

The prevalence of TB-HIV co-infection among TB cases with a documented HIV status[4] was 2.0% (28 cases). Twenty cases were diagnosed to be HIV positive within three months of TB diagnosis. The prevalence of TB-HIV co-infection among the new and relapsed TB cases were 1.8% (24 out of 1332 cases) and 4.5% (4 out of 89 cases) respectively. The highest TB-HIV co-infection rate among new and relapsed TB cases were observed among males above 60 years of age (Table 6.28). By ethnic group, Chinese males had the highest TB-HIV co-infection rate (Table 6.29).

[3] Global tuberculosis report 2018, WHO. Pg 35
[4] This refers to notified TB cases who were previously documented to be HIV-positive before TB diagnosis or had undergone HIV testing within three months of TB diagnosis.

Table 6.28
Age-gender distribution of new and relapsed cases with TB-HIV co-infection in Singapore residents, 2018

Age group	New and relapsed cases				TB-HIV co-infection rate per 100,000 population*		
	Male	Female	Total	%	Male	Female	Total
0-14	0	0	0	0	0	0	0
15-19	0	0	0	0	0	0	0
20-29	0	0	0	0	0	0	0
30-39	1	0	1	3.6	0.4	0	0.2
40-49	4	0	4	14.3	1.4	0	0.7
50-59	6	2	8	28.6	2.0	0.7	1.3
60+	14	1	15	53.6	3.6	0.2	1.8
Total	**25**	**3**	**28**	**100**			
Age-standardised rate ~ (per 100,00 population)					1.1	0.1	0.6
Crude Rate (per 100,00 population)					1.3	0.1	0.7

*Rates are based on 2018 estimated mid-year Singapore resident population and standardized population for age-standardised rate using 2010 mid-year Singapore resident population.
(Source: Singapore Department of Statistics).

Table 6.29
Ethnic-gender distribution of new and relapsed cases with TB-HIV co-infection in Singapore residents, 2018

Ethnic group	New and relapsed cases				TB-HIV co-infection rate per 100,000 population*		
	Male	Female	Total	%	Male	Female	Total
Chinese	21	1	22	78.6	1.5	0.1	0.7
Malay	3	1	4	14.3	1.1	0.4	0.7
Indian	1	1	2	7.1	0.5	0.6	0.6
Others	0	0	0	0	0	0	0
Total	**25**	**3**	**28**	**100**	**1.3**	**0.1**	**0.7**

*Rates are based on 2018 estimated mid-year Singapore resident population.
(Source: Singapore Department of Statistics).

TB cases in non-residents

In 2018, there were 1,353 new TB cases notified among non-residents in Singapore (Table 6.30). As in previous years, the number of new TB cases notified among short-staying foreigners outnumbered long-staying foreigners contributing 24.8% (Table 6.31) and 21.9% of total notified new cases, respectively (Table 6.32).

Table 6.30
New TB cases by pass category/status in non-residents, 2014-2018

	2014	2015	2016	2017	2018
Long-staying foreigners					
Work Permit Holders	409	353	473	446	402
Employment Pass Holder	27	36	44	40	53
Other Pass Holders*	128	113	176	169	180
Sub-total	**564**	**502**	**693**	**655**	**635**
Short-staying foreigners					
Work Permit Applicants	391	351	370	425	382
Visitors**	215	204	233	202	173
Others***	117	149	187	169	163
Sub-total	**723**	**704**	**790**	**796**	**718**
Total	**1,287**	**1,206**	**1,483**	**1,451**	**1,353**

* Includes dependent pass holder, long-term social visit pass holder, student pass holder and S pass holder.
** Short term social visitor.
*** Professional visit pass applicant, dependent pass applicant, long-term social visit pass applicant, student pass applicant, employment pass applicant, S pass applicant, illegal immigrant and other pass applicants.

Table 6.31
New TB cases by site of disease in short- staying foreigners, 2008-2018

Year	Pulmonary		Extra-pulmonary		Total	
	No.	% of total new cases notified	No.	% of total new cases notified	No.	% of total new cases notified
2008	412	16.8	81	3.3	493	20.2
2009	482	19.1	69	2.7	551	21.9
2010	672	24.1	91	3.3	763	27.3
2011	833	27.4	73	2.4	906	29.9
2012	832	26.7	85	2.7	917	29.4
2013	678	24.2	95	3.4	773	27.6
2014	641	23.4	82	3.0	723	26.3
2015	620	22.9	84	3.1	704	26.0
2016	690	22.3	100	3.2	790	25.5
2017	723	24.2	73	2.4	796	26.6
2018	649	22.4	69	2.4	718	24.8

Table 6.32
New TB cases by site of disease in long-staying foreigners, 2008-2018

Year	Pulmonary		Extra-pulmonary		Total	
	No.	% of total new cases notified	No.	% of total new cases notified	No.	% of total new cases notified
2008	403	16.5	97	4.0	500	20.5
2009	419	16.6	105	4.2	524	20.8
2010	462	16.6	88	3.2	550	19.7
2011	502	16.5	91	3.0	593	19.6
2012	538	17.2	105	3.4	643	20.6
2013	501	17.9	107	3.8	608	21.7
2014	485	17.7	79	2.9	564	20.6
2015	420	15.5	82	3.0	502	18.6
2016	577	18.6	116	3.7	693	22.4
2017	569	19.0	86	2.9	655	21.9
2018	549	18.9	86	3.0	635	21.9

Foreign-born residents

In 2018, drug resistance was detected in 20 (14.3%) of the 140 new pulmonary TB cases among foreign-born residents in whom DST was performed, whereby 15 (10.7%) were resistant to one drug and 5 (3.6%) were resistant to more than one drug (Table 6.33). Isoniazid resistance was detected in 10 cases (7.1%) while MDR-TB was detected in 2 cases (1.4%). There were no cases of pre-XDR or XDR-TB detected.

Drug resistance was detected in one (16.7%) of the 6 relapsed pulmonary TB cases with DST performed, and no MDR-TB was detected.

Table 6.33
***Mycobacterium tuberculosis* drug susceptibility in foreign-born residents with pulmonary TB, 2015-2018**

Sensitivity result of sputum examination*	**2015**		**2016**		**2017**		**2018**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
New cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin & Ethambutol	125	89.3	138	92.6	149	91.4	120	85.7
Resistant to:								
Single drug	12	8.6	11	7.4	9	5.5	15	10.7
More than 1 drug	3	2.1	0	0	5	3.1	5	3.6
Total	**140**	**100**	**149**	**100**	**163**	**100**	**140**	**100**
****Resistant to Isoniazid**	9	6.4	7	4.7	8	4.9	10	7.1
*****Phenotypic MDR**	0	0	0	0	3	1.8	2	1.4
******Genotypic MDR**	0	0	0	0	0	0	0	0
Total MDR	**0**	**0**	**0**	**0**	**3**	**1.8**	**2**	**1.4**
Relapsed cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin & Ethambutol	6	85.7	8	88.9	8	88.9	5	83.3
Resistant to:								
Single drug	1	14.3	0	0	0	0	1	16.7
More than 1 drug	0	0	1	11.1	1	11.1	0	0
Total	**7**	**100**	**9**	**100**	**9**	**100**	**6**	**100**
****Resistant to Isoniazid**	1	14.3	1	11.1	0	0	0	0
*****Phenotypic MDR**	0	0	0	0	1	11.1	0	0
******Genotypic MDR**	0	0	0	0	0	0	0	0
Total MDR	**0**	**0**	**0**	**0**	**1**	**11.1**	**0**	**0**

* In the case of dual lesions, the sensitivity result recorded was that of organisms cultured from sputum.
**Any of isoniazid resistance, exclusive of MDR.
*** Defined as cases which showed resistance to both rifampicin and isoniazid on DST.
****Defined as cases which showed Rifampicin resistance on genotypic test and Isoniazid resistance on DST.
Note: Extra-pulmonary MDR-TB was detected in 1 relapsed case among foreign-born residents in 2018

Non-residents

In 2018, drug resistance was detected in 53 (13.9%) of the 380 new pulmonary TB cases among non-residents in whom DST was performed, whereby 30 (7.9%) were resistant to one drug and 23 (6.1%) were resistant to more than one drug (Table 6.34). Isoniazid resistance was detected in 27 cases (7.1%) while MDR-TB was detected in 12 cases (3.2%), including 2 cases of pre-XDR-TB. There were no cases of XDR-TB.

Drug resistance was detected in 5 (29.4%) of the 17 relapsed pulmonary TB cases with DST performed, and 1 (5.9%) MDR-TB case was detected. There were no cases of pre-XDR or XDR-TB detected.

Table 6.34
***Mycobacterium tuberculosis* drug susceptibility in non-residents with pulmonary TB, 2015-2018**

Sensitivity result of sputum examination *	**2015**		**2016**		**2017**		**2018**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
New cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin & Ethambutol	287	86.5	383	83.8	355	84.7	327	86.0
Resistant to:								
Single drug	32	9.6	49	10.7	42	10.0	30	7.9
More than 1 drug	13	3.9	25	5.5	22	5.3	23	6.1
Total	**332**	**100**	**457**	**100**	**419**	**100**	**380**	**100**
****Resistant to Isoniazid**	27	8.1	33	7.2	27	6.4	27	7.1
*****Phenotypic MDR**	6	1.8	18	3.9	14[#]	3.3	11	2.9
******Genotypic MDR**	0	0	0	0	3	0.7	1[##]	0.3
Total MDR	**6**	**1.8**	**18**	**3.9**	**17**	**4.1**	**12**	**3.2**
Relapsed cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin & Ethambutol	11	68.8	4	50.0	11	84.6	12	70.6
Resistant to:								
Single drug	1	6.2	1	12.5	0	0	3	17.6
More than 1 drug	4	25.0	3	37.5	2	15.4	2	11.8
Total	**16**	**100**	**8**	**100**	**13**	**100**	**17**	**100**
****Resistant to Isoniazid**	3	18.8	1	12.5	0	0	2	11.8
*****Phenotypic MDR**	2	12.5	2	25.0	2	15.4	1	5.9
******Genotypic MDR**	0	0	0	0	0	0	0	0
Total MDR	**2**	**12.5**	**2**	**25.0**	**2**	**15.4**	**1**	**5.9**

* In the case of dual lesions, the sensitivity result recorded was that of organisms cultured from sputum.
**Any of isoniazid resistance, exclusive of MDR.
*** Defined as cases which showed resistance to both rifampicin and isoniazid on DST.
****Defined as cases which showed rifampicin resistance on genotypic test and isoniazid resistance on DST.
[#] Includes 2 MDR-TB cases that was notified as both pulmonary and extra-pulmonary TB, but where the MDR result was from the extra-pulmonary specimens only.
[##] MDR-TB case that was notified as both pulmonary and extra-pulmonary TB, but where the MDR result was from the extra-pulmonary specimen only.
Note: Extra-pulmonary MDR-TB was detected in 4 new cases (3 phenotypic & 1 genotypic) among non-residents in 2016. Extra-pulmonary MDR-TB was detected in 1 new case among non-residents in 2017.

TB mortality

In 2018, there were 28 deaths from TB among Singapore residents, giving a mortality rate of 0.7 case per 100,000 population (Table 6.35). The majority were males (82.1%) and those aged 70 years and above (60.7%).

Table 6.35
Age-gender distribution and age-specific mortality rate of TB, 2018

Age group	Male	Female	Total	%	Mortality rate per 100,000 population*
0–9	0	0	0	0	0
10–19	0	0	0	0	0
20-29	0	1	1	3.6	0.2
30–39	0	0	0	0	0
40–49	2	0	2	7.1	0.3
50–59	4	1	5	17.9	0.8
60–69	2	1	3	10.7	0.6
70+	15	2	17	60.7	5.1
Total	**23**	**5**	**28**	**100**	**0.7**

* Rates are based on 2018 estimated mid-year resident population.
(Source: Singapore Department of Statistics, Registry of Births & Deaths)

HEALTHCARE-ASSOCIATED OUTBREAKS

Healthcare-associated outbreaks are defined as clusters of infections in healthcare settings related in time and place, and occurring above a baseline or threshold level for a facility, specific unit, or ward. Healthcare settings include public and private hospitals, nursing homes, welfare homes and day-care centres.

The Healthcare Epidemiology (HCE) team is a team formed on 1 April 2016 within the Surveillance, Epidemiology and Response Branch of Communicable Diseases Division in MOH, to assist in the investigation of healthcare institutions associated outbreaks. The team comprised several field epidemiologists and a public health practitioner. In some outbreaks, member(s) of the National Outbreak Response Team are called upon by DMS to augment the outbreak investigation. The National Outbreak Response Team was set up in March 2016 to draw on national resources and expertise to enhance efforts in dealing with infectious diseases.

Suspected clusters of hospital acquired infections (HAIs) are reported to HCE early so that MOH can detect trends at the national level, monitor the situation and disseminate timely advice on infections/clusters that extend beyond individual hospitals. Table 6.36 lists the triggers and guiding criteria for reporting clusters of HAIs to the Ministry.

In 2018, a total of 44 healthcare-associated outbreaks were reported by hospitals and institution-based care facilities (Table 6.37). Of these, respiratory outbreaks accounted for the largest proportion with 742 cases (52.3 %) (Table 6.38).

Table 6.36
Guiding criteria for reporting outbreaks/ clusters of infectious diseases to MOH

Institution Type	Guiding Criteria
Hospital/ Community Hospital	When assessing whether to report an incident, the hospital should report the incident (which may involve Multidrug Resistant Organisms) to MOH as soon as possible, if any of the following guiding criteria are met: 1. Organism e.g. if it involves a pathogen or gene novel to the institution or country. 2. Potential impact beyond the institution e.g. if there is a: a. Risk of community transmission. b. Common product used beyond institution. c. Critical facility that relied upon nationally that is significantly affected especially if closure is being considered e.g. burns units and cardiothoracic intensive care unit (ICU). d. Population of patient with significant healthcare contact outside the facility is affected e.g. renal dialysis. 3. Institutional capability e.g. if the increase in the cluster size does not slow down despite control measures, or if assistance/resources are required to control outbreak. 4. Media sensitivity e.g. any incident which potentially may be media sensitive.
	Hospitals should also specifically report the following: 5. Cluster (2 or more cases) of a highly infectious agent (e.g. measles, chickenpox) with suspected transmission to staff or patient in a vulnerable population e.g. neonates, transplant and other immunocompromised patients, or critical facility e.g. ICUs, oncology wards, and operating rooms.
Institution-based care facilities	1. 10% of the total population (residents and staff) within 14 days are affected with the same illness. 2. 10 cases within 3 consecutive days. 3. Case(s) in the cluster that are severely ill [Dangerously Ill List (DIL) or in ICU] or died. [where this information is available].
Timeline for notification	All clusters/outbreaks of infectious diseases that are identified to have met MOH's reporting criteria, should be notified within 24 hours. After initial notification, the reporting institution will be required to provide daily situational updates to MOH. MOH will adjust the periodicity of the updates, when necessary.

Mode of notification	1. Email: reportidcluster@moh.gov.sg a. For hospitals/community hospitals – to submit Annex C (Reporting form for incident/cluster of healthcare-associated infections). Individual case details will be requested separately, if necessary. b. For institution-based care facilities – refer to email reporting template below: • Name of institution: e.g. ABC Nursing Home (COO Office) • Address of institution • Point-of-contact: e.g. Ms Lucy Goh (Manager) • Number of cases • Signs & symptoms

Table 6.37
Number of reported outbreaks in hospitals and institution-based care facilities, 2018

Type of institution	No. of outbreaks
Hospitals (private and public)	9
Community Hospitals	5
Institution-based care facilities	30
Total	**44**

Table 6.38
Healthcare associated outbreaks by disease condition, 2018

Institution type/ Disease Condition	No. of incidents	Total No. of cases (range)
Hospital (9)		
Respiratory	0	
Gastrointestinal	0	
Skin	0	
Multi-drug resistant organisms (MDRO)	4	20 (2-8)
Others	5 (CLABSI candidemia, *Staphylococcus aureus, Stenotrophomonas maltophilia* and HFMD)	33 (3-17)
Community Hospitals (5)		
Respiratory	2	58 (27 & 31)
Gastrointestinal	1	7
Skin	0	
MDRO	0	
Others	2 (Chickenpox)	8 (4)
Institution-based care facilities (30)		
Respiratory	21	684 (7-74)
Gastrointestinal	4	61 (11-18)
Skin	4 (Scabies)	40 (5-17)
MDRO	0	
Others	1 (Fever & vomiting)	9

Evaluating Effectiveness of the Influenza Vaccine during Respiratory Outbreaks

Influenza outbreaks occur periodically in Long Term Care Facilities (LTCFs) and vaccination is critical in preventing influenza infections. The MOH recommends annual influenza vaccination for those who are at increased risk of influenza-related complications, including persons aged 65 years and above and residents of these facilities. We evaluated the influenza vaccine effectiveness (VE) during respiratory outbreaks in LTCFs reported to MOH in 2017.

This study retrospectively examined the outbreaks in LTCFs that occurred between 1 January and 31 December 2017. A test-negative design was used to estimate the ratio of the odds of testing positive for influenza among vaccinated individuals to the odds among unvaccinated individuals. The VE was calculated as (1 odds ratio) x 100%. For adjusted VE, the estimates were derived using logistic regression adjusted for age group, gender, month of illness, and number of days from date of illness onset till swab collection date. Estimates of influenza subtypes and post-vaccination time period (15 – 180 days & 181 – 365 days) were also calculated using stratified data.

A total of 264 individuals, comprising of 146 (55.3%) controls and 118 (44.7%) cases whose dates of onset ranged from 11 January to 30 November 2017, were included in the analysis. 83 (56.9%) controls and 56 (47.5%) cases were vaccinated against influenza one year prior to onset of illness. Out of 118 cases, 32 (27.1%) cases tested positive for influenza A(H1N1)pdm09 and 75 (63.6%) were positive for A(H3N2), while the remaining 11 (9.3%) were positive for influenza A but were not subtyped due to low viral titres. No one tested positive for influenza B. A majority (83.1%) of the cases had influenza infections between April and July, which coincided with the southern hemisphere influenza season.

The overall adjusted VE estimate was 40.6% (95% CI: -12.2 – 68.5%), while the subtype-specific adjusted VE estimates were 43.4% (95% CI: -312.4 – 50.2%) against A(H1N1)pdm09 and 57.1% (95% CI: 5.7 – 80.5%) against A(H3N2). At 15 – 180 days post-vaccination period, the adjusted VEs were 59.3% (95% CI: 18.0 – 79.8%) against all influenza, 35.4% (95% CI: -123.5 – 81.3%) against A(H1N1)pdm09 and 67.9% (95% CI: 22.5 – 86.7%) against A(H3N2). Estimates were not significant at 181 – 365 days post-vaccination.

Overall, the influenza vaccine was moderately effective in Singapore's LTCFs in 2017, with a higher effectiveness in people who were more recently vaccinated. It remains an important public health measures in preventing influenza infections, especially for those who are at high risk of influenza-related complications.

SEVERE ILLNESS AND DEATH FROM POSSIBLY INFECTIOUS CAUSES

The SIDPIC (Severe Illness and Death from Possibly Infectious Causes) programme is a hospital-based sentinel surveillance programme that reviews cases of unexplained deaths and critical illnesses to identify possible emerging infections caused by novel pathogens. It aims to reduce delays in recognising emerging infections of public health importance. SIDPIC is operational in seven public hospitals, namely TTSH, NUH, SGH, KKH, CGH, and NTFGH, with recent extension to SKH (since 18 July 2018) (See Table 6.39).

The majority of illnesses among SIDPIC cases (35.3%) were respiratory syndromes, followed by neurological illnesses (17.3%) (Table 6.40). Of the 428 unique cases identified in 2018, 269 (62.9%) cases were assessed to have an alternate aetiology, i.e. it was deemed that a pathogen was likely to have caused the illness. Of these 269 cases, a causative pathogen was subsequently identified by laboratory testing in the course of clinical care in 144 (53.5%) cases. No causative pathogen was identified in the remaining 125 (46.5%) cases, although the clinical presentation and/or other investigational evidence suggested an infectious aetiology.

Among the 144 SIDPIC cases where causative pathogens were identified, respiratory viruses constituted majority (89 cases, 61.8%) of all pathogens. Respiratory syncytial virus (25.8%), enterovirus/rhinovirus (19.1%) and influenza viruses (12.4%) were the most commonly detected respiratory viruses.

Despite extensive laboratory testing, the aetiology in 159 (37.2%) cases remained unknown. Table 6.41 lists the pathogens which may be tested for under the SIDPIC programme.

Table 6.39
SIDPIC performance indicators, 2018

Surveillance Indicators	CGH	KKH	NTFGH	NUH	SGH	TTSH	SKH	Total
No. of cases screened*	3,650	900	5,155	700	3,018	7,096	944	**21,463**
Death	738 (20.2%)	109 (12.1%)	1,298 (25.2%)	74 (10.6%)	241 (8.0%)	3,112 (43.9%)	261 (27.6%)	**5,833**
Non-death	2,912 (79.8%)	791 (87.9%)	3,857 (74.8%)	626 (89.4%)	2,777 (92.0%)	3,984 (56.1%)	683 (72.4%)	**15,630**
No. of SIDPIC cases	**11**	**66**	**186**	**41**	**31**	**94**	**2**	**431^**
Aetiology Found	8 (72.7%)	31 (47.0%)	155 (83.3%)	18 (43.9%)	13 (41.9%)	43 (45.7%)	1 (50.0%)	**269**
Unknown Aetiology	3 (27.3%)	35 (53.0%)	31 (16.7%)	23 (56.1%)	18 (58.1%)	51 (54.3%)	1 (50.0%)	**162**
Co-morbidity Found	2	0	0	0	0	0	0	**2**
No. of missed cases#	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

* The total number of cases screened refers to the sum of ICU admissions and death certificates screened.
^ Included 3 duplicate cases who were transferred from one hospital to another.
# Based on surrogate indicator (invasive pneumococcal disease, IPD) notified to MOH that are not identified as SIDPIC cases. There were a total of 100 IPD cases notified to MOH in 2018 and not identified as SIDPIC cases; none of them fulfilled SIDPIC recruitment criteria.

Table 6.40
Distribution of SIDPIC cases based on syndrome* classification, 2018

Syndrome	Aetiology Found	Unknown Aetiology	Total	%
Cardiac	40	22	62	14.5
Gastrointestinal	9	6	15	3.5
Neurological	44	30	74	17.3
Respiratory	103	48	151	35.3
Others	13	5	18	4.2
Multisystem	60	48	108	25.2
Total	**269**	**159**	**428**	**100**

* Syndrome classification:
Neurological – meningitis or encephalitis
Cardiac – myocarditis, pericarditis, endocarditis
Respiratory – pneumonia, acute respiratory distress syndrome (ARDS), respiratory failure
Gastrointestinal – hepatitis, hepatic failure, severe diarrhoea
Others – syndromes apart from the above four
Multisystem – sepsis, haemorrhagic fever, rash, shock

Table 6.41 SIDPIC Lab Test Panels

	Pneumonia		Encephalitis		Viral Haemorrhagic Fever
First line panel*	**Respiratory Samples** Multiplex PCR, Influenza PCR, H5N1 PCR, SARSCoV PCR, MERS-CoV PCR, TB PCR **Blood** Bacterial culture, *Mycoplasma* serology, *Legionella* serology, *Chlamydia* serology, H5N1 PCR, SARS-CoV PCR	**Urine** Urine culture, Pneumococcal Ag, *Legionella* Ag **Other samples (e.g. lung tissue)** PCP stain, Fungal stain	**Cerebrospinal Fluid** Bacterial culture, AFB PCR & culture, Fungal culture, Enterovirus PCR, HSV/ CMV/ VZV/ EBV PCR, Dengue PCR, JE IgM, PCR, WNV PCR, Nipah PCR **Respiratory Samples** EV PCR, Nipah PCR	**Stool** Enterovirus PCR, Poliovirus PCR **Other samples (e.g. Brain tissue)** Histopathology	**Blood & Respiratory Samples** Dengue PCR & serology, Chikungunya PCR & serology, Yellow fever PCR & serology, Lassa, Ebola, Marburg fever
Second line panel#	**Blood** *Brucella* serology **Respiratory Samples** Viral isolation, Hantaan virus PCR, Nipah PCR		**Cerebrospinal Fluid** Viral isolation, also consider lymphocytic choriomeningitis virus, Rickettsial isolation, Kunjin Chandipura, Measles, Polio, Rabies, and other viral encephalitides dependent on travel history, e.g. WEE, SLE, VEE, Kyasanur forest disease (India)	Toscana (from Europe/ Spain) Sindbis virus (Europe/ Australia/ Asia) **Stool** Viral isolation **Other samples (e.g. Brain tissue)** EM	**Blood & Respiratory Samples** VEE, CCHF, RVF, and other South American arenaviruses, e.g. Junin, Machupo, Guanarito, and Sabia viruses, depending on travel history, HFRS virus isolation EM
	Myocarditis		**Gastrointestinal**		
First line panel*	**Blood** EV71 PCR **Stool** Enterovirus PCR	**Other samples (e.g. Cardiac tissue)** Histopathology	**Stool** Vibrio Cholera, *E. coli* O157:H7	**Other samples (e.g. Liver/ intestinal tissue)** Histopathology, Special stains	**Blood** Bacterial culture, Yellow fever PCR & serology
Second line panel#	**Blood** Virus isolation	**Other samples (e.g. Cardiac tissue)** EM, special stains	**Stool** Rotavirus, astrovirus, sapovirus, adenovirus 40.41, Norovirus PCR, Viral isolation	**Other samples (e.g. Liver/ intestinal tissue)** EM, special stains	

* **First line panel:** These are the first-line tests which may be conducted after a check has been made to ensure that these pathogens have not already been tested for as part of the patient's clinical management.

\# **Second line panel:** These tests may be conducted after the SIDPIC physician and the laboratory have evaluated the epidemiological and clinical features of the case.

Legend:			
AFB	= Acid-fast bacillus	**SLE**	= St Louis encephalitis
Ag	= Antigen	**TB**	= Tuberculosis
CCHF	= Crimean-Congo haemorrhagic fever	**VEE**	= Venezuelan equine encephalitis
CMV	= Cytomegalovirus	**VZV**	= Varicella zoster virus
***E. coli* O157:H7**	= *Escherichia coli* serotype O157:H7	**WEE**	= Western equine encephalitis
EBV	= Epstein-Barr virus	**WNV**	= West Nile Virus
EM	= Electron microscopy		
EV	= Enterovirus		
EV71	= Enterovirus Type 71		
H5N1	= Influenza A virus subtype H5N1		
HFRS	= Haemorrhagic fever with renal syndrome		
HSV	= Herpes simplex virus		
JE IgM	= Japanese encephalitis immunoglobulin		
M MERS-CoV	= Middle East respiratory syndrome coronavirus		
PCP	= *Pneumocystis carinii* pneumonia		
PCR	= Polymerase chain reaction		
RVF	= Rift Valley fever		
SARS-CoV	= Severe acute respiratory syndrome coronavirus		

CHAPTER 7

CHILDHOOD IMMUNISATION

Immunisation is the best way to protect infants, children, teenagers and adults from vaccine-preventable diseases. Some of these diseases can be very serious, requiring hospitalisation or even resulting in death. Vaccines contain an agent that resembles a disease-causing microorganism to simulate the body's immune response to recognise the infectious agent, which allows for an effective response during a real encounter.

HISTORY OF THE IMMUNISATION PROGRAMME

The National Childhood Immunisation Programme (NCIP) in Singapore covers vaccinations against TB (BCG); hepatitis B (HepB); diphtheria, pertussis and tetanus (DTaP); poliomyelitis (IPV/OPV); *Haemophilus influenzae* type b (Hib); measles, mumps and rubella (MMR); pneumococcal disease (PCV); and human papillomavirus (HPV) (Table 7.1). Only vaccinations against diphtheria and measles are compulsory by law. In November 2017, MOH introduced the National Adult Immunisation Schedule (NAIS) to provide guidance on vaccines recommended for adults (i.e. persons aged 18 years and above) and increase awareness on the importance of adult vaccination for personal protection. See Table 7.2 for the list of recommended vaccines in the NAIS.

BCG vaccination began in mid-1950s as part of the NCIP and newborns were vaccinated at birth. Although parental consent is required, acceptance has been high and close to 100% of newborns have been vaccinated in the last decade (Table 7.3). The introduction of BCG vaccination has contributed significantly to the elimination of TB meningitis in young children. Since July 2001, guidelines have been revised to discontinue BCG in Mantoux non-reactors as well as BCG booster doses.

Hepatitis B vaccination for infants born to hepatitis B carrier mothers was incorporated into the NCIP in October 1985. This was extended to all newborns in September 1987. To protect those born before 1987, a four-year catch-up hepatitis B vaccination programme was implemented for students from secondary schools to tertiary institutions as well as full-time national servicemen (NSFs) from 2001 to 2004.

Since January 1990, the monovalent measles vaccine given to one-year-old children was replaced by the trivalent MMR vaccine. From January 1998, the monovalent rubella vaccine given to primary six children (11-12 years of age) was also replaced by the second dose of MMR vaccine. The MMR vaccination schedule was last reviewed by the Expert Committee on Immunisation (ECI) in 2011 and the revised schedule was implemented in December of the same year. With the change in the schedule, both doses of MMR vaccine were brought forward to 12 months and 15-18 months of age, respectively. Health Promotion Board (HPB) continues to provide MMR vaccination as a catch-up for primary one students (6-7 years of age) who did not receive the second dose in their pre-school years.

Pneumococcal conjugate vaccine (PCV) was included as the 10th vaccine in the NCIP in November 2009 to reduce morbidity and mortality of invasive pneumococcal disease (IPD) in Singapore. The ECI recommended a schedule of two doses for the primary series and one booster dose (2+1 schedule). The two doses in the primary series are given at ages 3 and 5 months, and a single booster dose at 12 months of age.

Human papillomavirus (HPV) vaccination was first introduced into the NCIP in November 2010 and recommended for females aged 9 to 26 years old for the prevention of cervical cancer. The HPV vaccination for adult females (18 to 26 years) was subsequently consolidated into the NAIS in 2017 together with other recommended vaccination for adults to emphasise the importance of vaccinations in adults. HPV vaccination is recommended as a two-dose series at 0 and 6 months for younger females who initiate the vaccination series at ages 9-13 years; a three-dose series is recommended for older females aged 14-26 years at 0, 1-2 and 6 months.

The polio vaccination schedule prior to June 2013 comprised of six doses of oral polio vaccine (OPV). In order to reduce the risk of vaccine-associated paralytic poliomyelitis (VAPP), the ECI recommended to switch the first four doses from OPV to inactivated polio vaccine (IPV). The new five-dose schedule consists of four IPV doses, with three primary doses given at 3, 4, and 5 months of age, and the first booster dose at 18 months of age. OPV was retained for the fifth and final dose, recommended at 10-11 years of age (primary five). The OPV dose at 6-7 years of age (primary one) was discontinued at the end of 2013.

Trivalent OPV (tOPV, containing poliovirus types 1, 2 and 3) was replaced with bivalent OPV (bOPV, containing poliovirus types 1 and 3) in 2016 to meet the World Health Organization's (WHO) requirement to switch from tOPV to bOPV. The reason for the switch was to eliminate the risk of outbreaks associated with type 2 component of tOPV, as vaccine-related poliovirus can circulate in unvaccinated individuals and may lead to paralysis, similar to wild poliovirus (WPV). Protection against WPV type 2 (WPV2) is no longer necessary, as WPV2 has been certified as eradicated by the Global Commission for the Certification of Poliomyelitis Eradication (GCC) in 2015. However, to provide some protection against circulating vaccine-derived poliovirus type 2, WHO recommends that all countries introduce at least one dose of IPV in their routine immunisation programmes.

Haemophilus influenzae type b (Hib) vaccination was introduced into the NCIP to reduce the risk of invasive disease such as meningitis and sepsis which may lead to long-term disabilities or death. The ECI recommended a four-dose schedule, in line with the schedule for DTaP and IPV at 3, 4, and 5 months of age and a single booster dose at 18 months of age. The ECI also recommended the use of combination vaccines containing DTaP, IPV and Hib for the routine schedule in June 2013.

IMPLEMENTATION OF THE IMMUNISATION PROGRAMME

The NCIP is carried out by:
(a) Public and private hospitals with neonatal immunisation services;
(b) National Healthcare Group Polyclinics (NHGP), National University Polyclinics (NUP) and Singhealth Polyclinics (SHP);
(c) Paediatric clinics in KK Women's and Children's Hospital (KKH) and National University Hospital (NUH);
(d) Private general practice (GP) and paediatric clinics;
(e) Youth Preventive Services Division (YPSD), Health Promotion Board (HPB).

Vaccination of newborns for birth doses is carried out at public and private hospitals with neonatal immunisation services. Vaccination of infants and pre-school children is carried out at polyclinics, paediatric clinics in public hospitals, and private GP and paediatric clinics. The target population is based on notification of births obtained from the Registry of Births and Deaths.

Vaccination of primary school children is carried out by HPB. The target population is based on student population data from the Ministry of Education.

Table 7.1
Singapore's National Childhood Immunisation Schedule (NCIS), 2018

Vaccination against	Birth	1 month	3 months	4 months	5 months	6 months	12 months	15 months	18 months	10-11 years*
Tuberculosis	**BCG**									
Hepatitis B	**HepB (D1)**	**HepB (D2)**			**HepB (D3)†**					
Diphtheria, tetanus and pertussis			**DTaP (D1)**	**DTaP (D2)**	**DTaP (D3)**				**DTaP (B1)**	**Tdap (B2)**
Poliomyelitis			**IPV (D1)**	**IPV (D2)**	**IPV (D3)**				**IPV (B1)**	**OPV (B2)**
Haemophilus influenzae type b			**Hib (D1)**	**Hib (D2)**	**Hib (D3)**				**Hib (B1)**	
Measles, mumps and rubella							**MMR (D1)**	**MMR (D2)§**		
Pneumococcal disease			**PCV (D1)**		**PCV (D2)**		**PCV (B1)**			
Human papillomavirus	*HPV2 and HPV4 are recommended for **females aged 9 to 25 and 9 to 26 years**, respectively. Females aged **9 to 13 years**: two doses are recommended at the interval of **0 and 6 months**. Females aged **14 to 26 years**: **three doses** are recommended at the interval of **0, 1-2, 6 months**.*									

Footnotes:

BCG	Bacillus Calmette-Guérin vaccine
HepB	Hepatitis B vaccine
DTaP	Paediatric diphtheria and tetanus toxoids and acellular pertussis vaccine
Tdap	Tetanus toxoid, reduced diphtheria toxoid and acellular pertussis vaccine
IPV	Inactivated polio vaccine
OPV	Oral polio vaccine
Hib	Haemophilus influenzae type b vaccine
MMR	Measles, mumps and rubella vaccine
PCV	Pneumococcal conjugate vaccine
HPV2	Bivalent human papillomavirus vaccine
HPV4	Quadrivalent human papillomavirus vaccine
D1/D2/D3	1st dose, 2nd dose, 3rd dose
B1/B2	1st booster dose, 2nd booster bose
*	Primary 5
†	3rd dose of HepB can be given at the same time as the 3rd dose of DTaP, IPV, and Hib for the convenience of parents.
§	2nd dose of MMR can be given between 15 and 18 months

Table 7.2
Singapore's National Adult Immunisation Schedule (NAIS), 2018

Vaccine	18-26 years	27-64 years	≥ 65 years
Influenza	1 dose annually		1 dose annually
Pneumococcal*	1 or 2 doses (depending on indication)		1 dose each*
Human papillomavirus (HPV)†	3 doses		
Tetanus, diphtheria and pertussis (Tdap)	1 dose per pregnancy		
Measles, mumps and rubella (MMR)	2 doses		
Hepatitis B	3 doses		
Varicella	2 doses		

Recommended for adults who meet age requirement

Recommended for adults with specific medical conditions or indications

Recommended for adults who have not been previously vaccinated or lack evidence of past infection / immunity

Footnotes:
** Pneumococcal vaccines in the NAIS include 13-valent pneumococcal conjugate vaccine (PCV13) and 23-valent pneumococcal polysaccharide vaccine (PPSV23).*
† Two types of HPV vaccines are in the NAIS – bivalent HPV vaccine (HPV2) and quadrivalent HPV (HPV4) vaccine.

Notification of vaccination

The data utilised in this report was based on:

(a) Notifications of all vaccinations carried out in infants and pre-school children by healthcare institutions in both the public and private sectors to the National Immunisation Registry (NIR) at HPB. Notification of diphtheria and measles immunisations are compulsory by law; and

(b) Vaccination records kept by YPSD for vaccinations administered in schools and at the Immunisation Clinic, Student Health Centre, HPB.

Notification of vaccinations recommended in the NAIS are voluntary and not included in this report.

All data are updated annually (including figures for the preceding years).

Vaccination against TB

In 2018, BCG vaccination was given to 33,113 infants, with a coverage of 98.2% (Table 7.3).

Table 7.3
BCG vaccination of infants, 2009-2018

Year	Public hospitals (%)	Polyclinics (%)	Private clinics & hospitals (%)	Total	Coverage for children at 2 years of age* (%)
2009	13,987 (42.1)	98 (0.3)	19,150 (57.6)	33,235	99.4
2010	13,937 (42.4)	84 (0.3)	18,822 (57.3)	32,843	99.5
2011	13,315 (41.8)	67 (0.2)	18,496 (58.0)	31,878	99.5
2012	12,294 (41.1)	111 (0.4)	17,525 (58.6)	29,930	99.3
2013	12,684 (40.9)	49 (0.2)	18,284 (58.9)	31,017	99.3
2014	13,119 (39.4)	43 (0.1)	20,173 (60.5)	33,335	98.8
2015	12,564 (40.5)	54 (0.2)	18,442 (59.4)	31,060	99.3
2016	14,178 (41.6)	74 (0.2)	19,792 (58.1)	34,044	99.1
2017	14,341 (42.9)	67 (0.2)	18,985 (56.9)	33,393	98.6
2018	14,835 (44.8)	4 (0.0)	18,274 (55.2)	33,113	98.2

* Coverage refers to vaccination given to all Singaporean and Singapore Permanent Resident (PR) children.

Vaccination against diphtheria, pertussis and tetanus

Infants and pre-school children

In 2018, the primary course of vaccination was given to 32,538 children, with a coverage of 96.5%. The first booster dose was given to 30,143 children by two years of age (89.4%) (Table 7.4).

Table 7.4
Diphtheria, pertussis and tetanus vaccination of infants and pre-school children, 2009-2018

Year	Coverage for children at 2 years of age*			
	Completed primary course		1st booster dose given	
	No.	Coverage (%)	No.	Coverage (%)
2009	32,662	97.7	31,063	92.9
2010	32,057	97.1	30,202	91.5
2011	31,046	96.9	29,431	91.9
2012	29,376	97.5	27,804	92.3
2013	30,452	97.5	28,881	92.5
2014	32,689	96.9	30,742	91.1
2015	30,312	96.9	28,467	91.0
2016	33,272	96.8	31,369	91.3
2017	32,599	96.3	30,958	91.4
2018	32,538	96.5	30,143	89.4

* Coverage refers to vaccinations given to all Singaporean and Singapore PR children.

School children

In 2018, the second booster dose (Tdap) was given to 38,316 primary five students (92.9%) (Table 7.5).

Table 7.5
Diphtheria, tetanus and pertussis vaccination (Tdap) of primary five students (10-11 years of age), 2009-2018

Year	Total no. of primary 5 students	2nd booster dose given*	
		No.	Coverage (%)
2009	45,498	43,558	95.7
2010	45,555	43,554	95.6
2011	49,071	46,175	94.1
2012	43,579	40,380	92.7
2013	42,901	39,547	92.2
2014	40,065	36,691	91.6
2015	39,865	37,036	92.9
2016	40,044	36,913	92.2
2017	40,770	37,634	92.3
2018	41,260	38,316	92.9

* Coverage is inclusive of vaccinations given by private practitioners.

Vaccination against *Haemophilus influenzae* type b

In 2018, the primary course of *Haemophilus influenzae* type b (Hib) vaccination was given to 32,501 children (96.4%). The booster dose was given to 29,862 children by two years of age (88.6%) (Table 7.6).

Table 7.6
Haemophilus influenzae* type b vaccination of infants and pre-school children, 2009-2018

Year	Coverage for children at 2 years of age†			
	Completed primary course		Booster dose given	
	No.	Coverage (%)	No.	Coverage (%)
2009	26,093	78.0	25,188	75.3
2010	25,925	78.5	24,623	74.6
2011	25,883	80.8	24,795	77.4
2012	24,813	82.4	23,760	78.9
2013	26,444	84.7	25,535	81.8
2014	29,024	86.0	28,315	83.9
2015	30,113	96.2	28,105	89.8
2016	33,202	96.6	31,293	91.1
2017	32,539	96.1	30,902	91.3
2018	32,501	96.4	29,862	88.6

* Hib vaccination was introduced into the NCIP in 2013.
† Coverage refers to vaccinations given to all Singaporean and Singapore PR children.

Vaccination against poliomyelitis

Infants and pre-school children

In 2018, primary polio vaccination was given to 32,532 children, with a coverage of 96.5%. The first booster dose was given to 30,114 children by two years of age (89.3%) (Table 7.7).

School children

In 2018, the second booster dose was given to 39,274 primary five students (95.2%) (Table 7.8).

Table 7.7
Polio vaccination of infants, pre-school and school children, 2009-2018

Year	Coverage for children at 2 years of age*				School Children		
	Completed primary course		1st booster dose given		2nd booster dose given§		
	No.	Coverage (%)	No.	Coverage (%)	School entrants	No.	Coverage (%)
2009	32,650	97.7	30,866	92.3	43,142	40,254	93.3
2010	32,035	97.0	30,112	91.2	39,465	37,520	95.1
2011	31,032	96.9	29,344	91.6	39,886	37,219	93.3
2012	29,376	97.5	27,724	92.0	40,191	37,301	92.8
2013	30,447	97.5	28,813	92.2	40,382	37,765	93.5
2014	32,677	96.9	30,681	90.9	-	-	-
2015	30,306	96.9	28,338	90.6	-	-	-
2016	33,256	96.8	31,326	91.2	-	-	-
2017	32,593	96.3	30,905	91.3	-	-	-
2018	32,532	96.5	30,114	89.3	-	-	-

* Coverage refers to vaccinations given to all Singaporean and Singapore PR children.
§ The OPV booster dose for school entrants was discontinued at the end of 2013.

Table 7.8
Polio vaccination of primary five students (10-11 years of age), 2009-2018

Year	Total no. of primary 5 students	Booster dose given*	
		No.	Coverage (%)
2009	45,498	44,215	97.2
2010	45,555	44,622	98.0
2011	49,071	47,891	97.6
2012	43,579	42,366	97.2
2013	42,901	41,975	97.8
2014	40,065	39,066	97.5
2015	39,865	38,903	97.6
2016	40,044	39,008	97.4
2017	40,770	39,697	97.4
2018	41,260	39,274	95.2

* Coverage refers to vaccinations given to all Singaporean and Singapore PR children.

Vaccination against measles, mumps and rubella

Pre-school children

In 2018, the first dose of measles, mumps and rubella vaccination was completed in 32,216 children (95.6%). The second dose was given to 29,670 children by two years of age (88.0%) (Table 7.9).

Table 7.9
Measles, mumps and rubella vaccination of pre-school and primary school children, 2009-2018

Year	Coverage for children at 2 years of age*				Primary school children†	
	Dose 1		Dose 2§		Dose 2§	
	No.	Coverage (%)	No.	Coverage (%)	No.	Coverage (%)
2009	32,121	96.1	-	-	40,391	93.6
2010	31,363	95.0	-	-	37,518	95.1
2011	30,598	95.5	-	-	37,084	93.0
2012	28,827	95.7	-	-	36,903	91.8
2013	30,004	96.1	27,437	87.8	-	-
2014	32,299	95.7	30,088	89.2	-	-
2015	29,847	95.4	28,390	90.7	-	-
2016	32,822	95.5	31,278	91.0	-	-
2017	32,418	95.8	31,090	91.8	-	-
2018	32,216	95.6	29,670	88.0	-	-

* Coverage refers to vaccinations given to all Singaporean and Singapore PR children.
† Coverage among all students aged 6-7 years (primary one) from 2009 to 2011 (reported up to 2012).
§ Dose 2 was administered in primary schools at 11-12 years of age (primary six) up to 2007 and 6-7 years of age (primary one) from 2008 to 2011 (reported up to 2012). From December 2011, dose 2 has been administered at 15-18 months of age (reported from 2013).

Vaccination against hepatitis B

In 2018, the primary course of hepatitis B vaccination was given to 32,467 children, with a coverage of 96.3% (Table 7.10).

Table 7.10
Hepatitis B vaccination of infants and pre-school children, 2009-2018

Year	Coverage for children at 2 years of age who completed primary course*	
	No.	Coverage (%)
2009	32,493	97.2
2010	31,885	96.6
2011	30,903	96.5
2012	29,312	97.3
2013	30,363	97.2
2014	32,612	96.7
2015	30,247	96.7
2016	33,188	96.6
2017	32,581	96.2
2018	32,467	96.3

* Coverage refers to vaccinations given to all Singaporean and Singapore PR children.

Vaccination against pneumococcal disease

In 2018, the primary course of pneumococcal vaccination was given to 29,768 children, with a coverage of 88.3%. The booster dose was given to 27,966 children by two years of age (83.0%) (Table 7.11).

Table 7.11
Pneumococcal vaccination of infants and pre-school children, 2009-2018

Year	Coverage for children at 2 years of age*			
	Completed two-dose primary course†		Booster (3rd) dose given	
	No.	Coverage (%)	No.	Coverage (%)
2009	8,395	25.1	5,492	16.4
2010	10,032	30.4	7,200	21.8
2011	16,625	51.9	13,065	40.8
2012	19,712	65.4	15,826	52.5
2013	22,642	72.5	19,002	60.8
2014	26,682	79.1	23,298	69.1
2015	25,940	82.9	23,644	75.6
2016	29,349	85.4	26,904	78.3
2017	29,737	87.8	27,687	81.8
2018	29,768	88.3	27,966	83.0

* Coverage refers to vaccinations given to all Singaporean and Singapore PR children.
† Starting from 2017 publication, the coverage for the completion of primary course is reported at 2 years of age, instead of 1 year as reported in previous publications up to 2016.

EFFECTIVENESS OF THE IMMUNISATION PROGRAMME

The effectiveness of childhood immunisation programme against poliomyelitis and diphtheria is shown in Figures 7.1 and 7.2. In 2018, no indigenous case of poliomyelitis or neonatal tetanus was reported.

Figure 7.1
Incidence of reported poliomyelitis cases and vaccination coverage in Singapore, 1946-2018

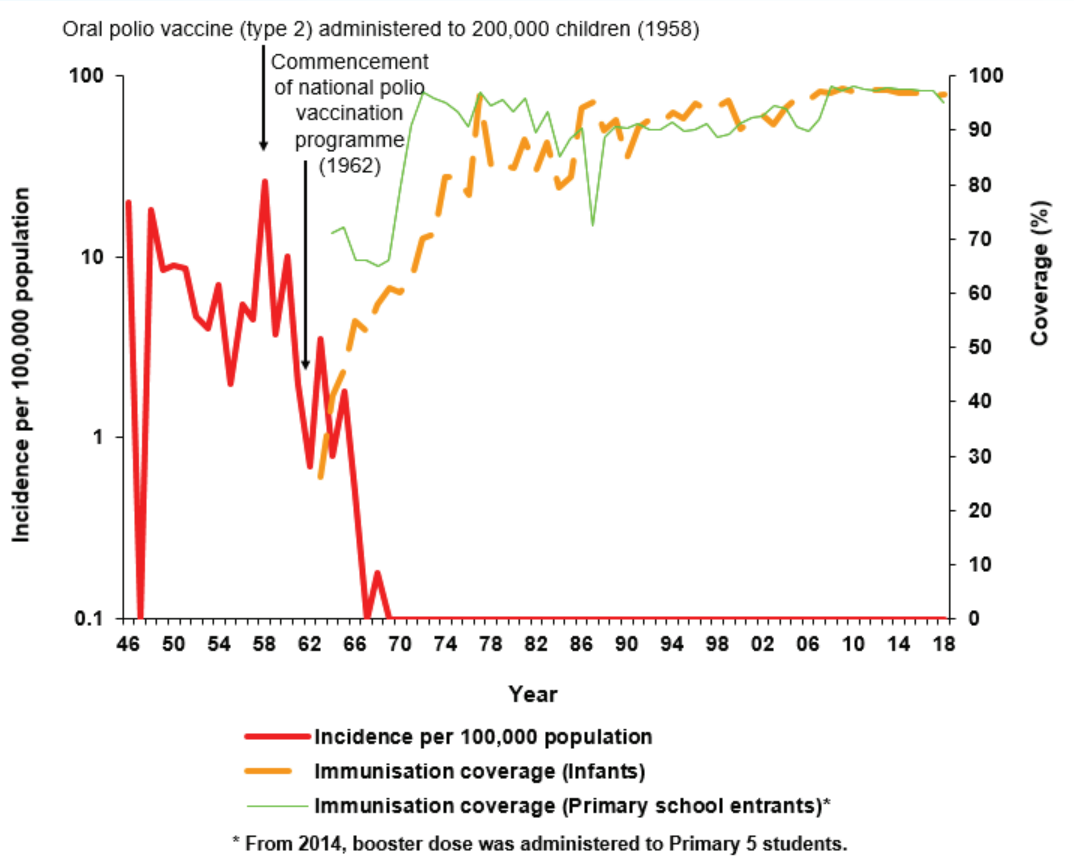
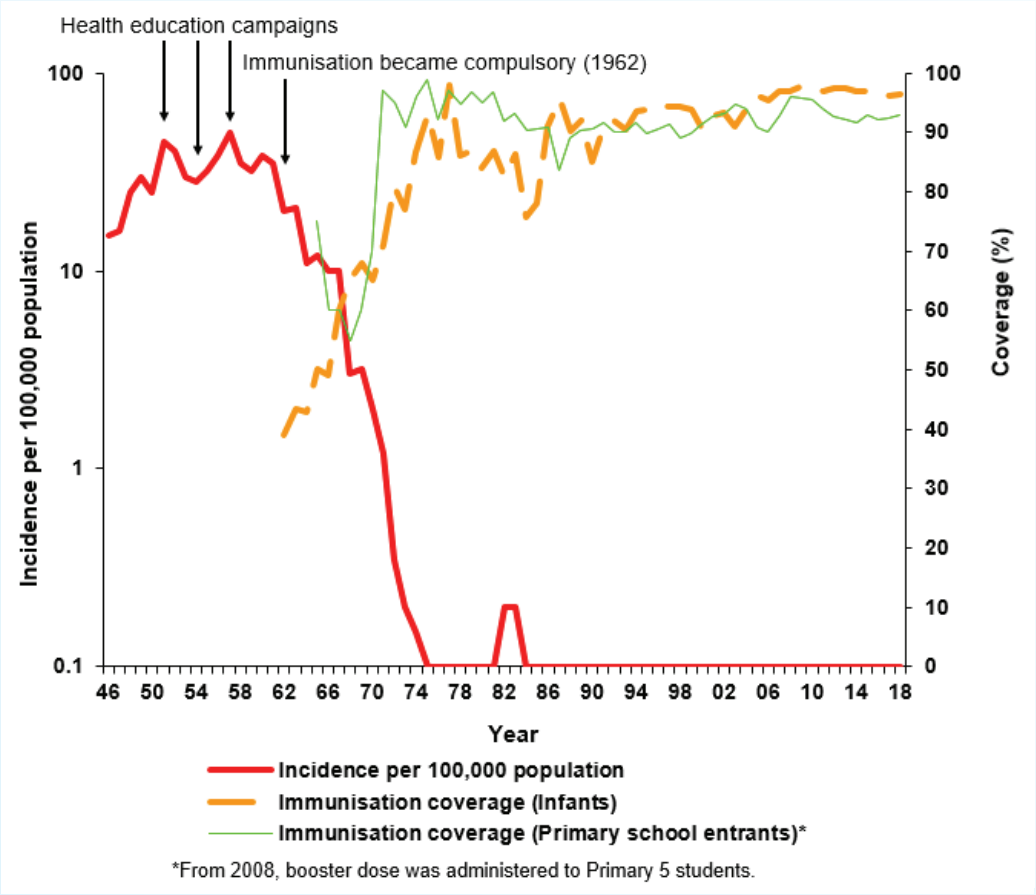
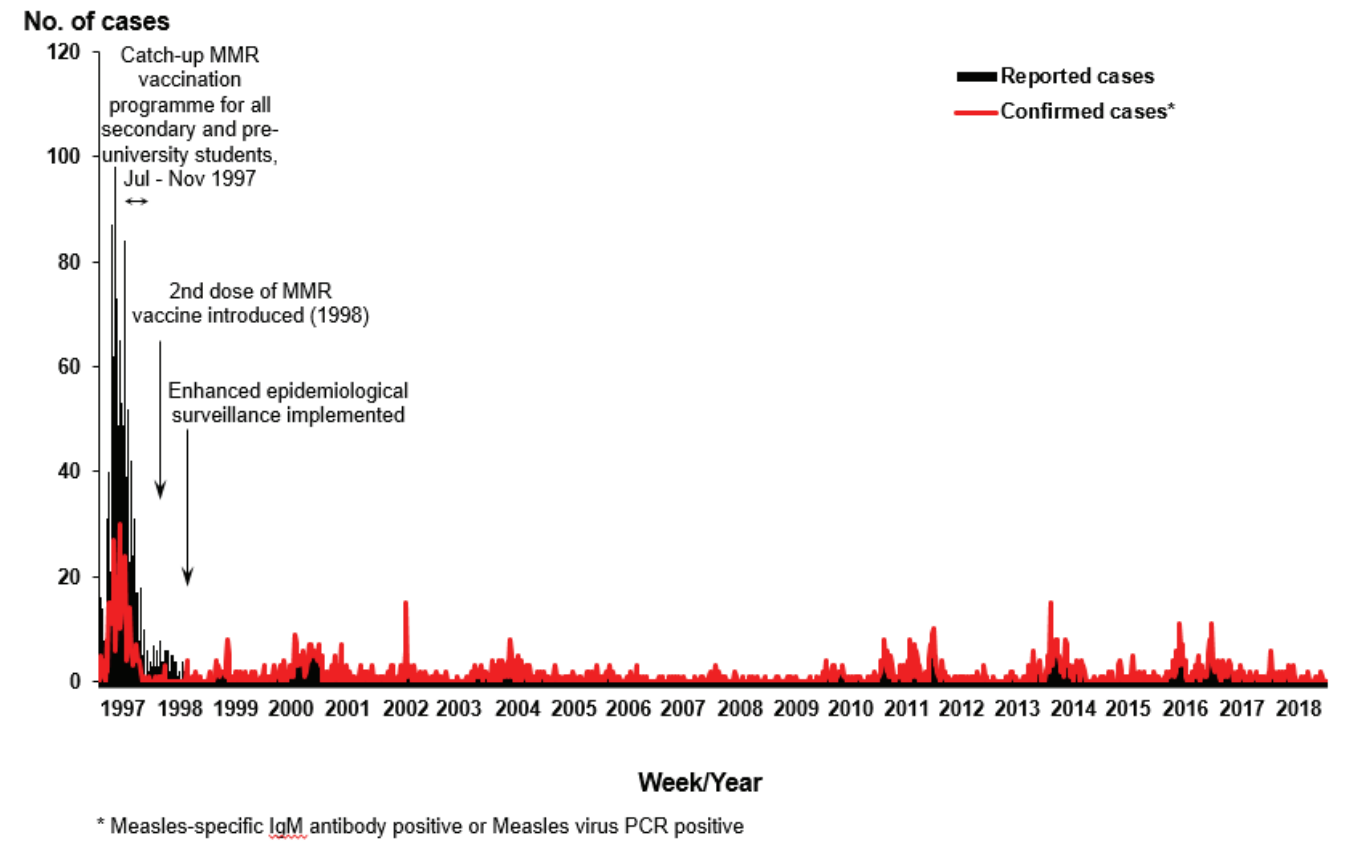


Figure 7.2
Incidence of reported diphtheria cases and vaccination coverage in Singapore, 1946-2018



With the implementation of 'catch-up' measles vaccination programme using the MMR vaccine in 1997, and the introduction of the second dose of MMR vaccine to all primary six school children (11-12 years of age) in 1998 and subsequent changes to the immunisation schedule for the second dose (to primary one school children aged 6-7 years in 2008 and 15-18 months of age in 2011), the number of reported cases of measles decreased from 1,413 cases in 1997 to 34 in 2018 (Figure 7.3).

Figure 7.3
Impact of catch-up MMR vaccination programme and introduction of second dose of MMR vaccine on the number of reported measles cases in Singapore, 1997-2018



The number of reported cases of rubella decreased from 48 cases in 2013 to 10-17 cases since then. There was no reported case of indigenous congenital rubella although two termination of pregnancy due to rubella infection was carried out in 2018 (Table 7.12).

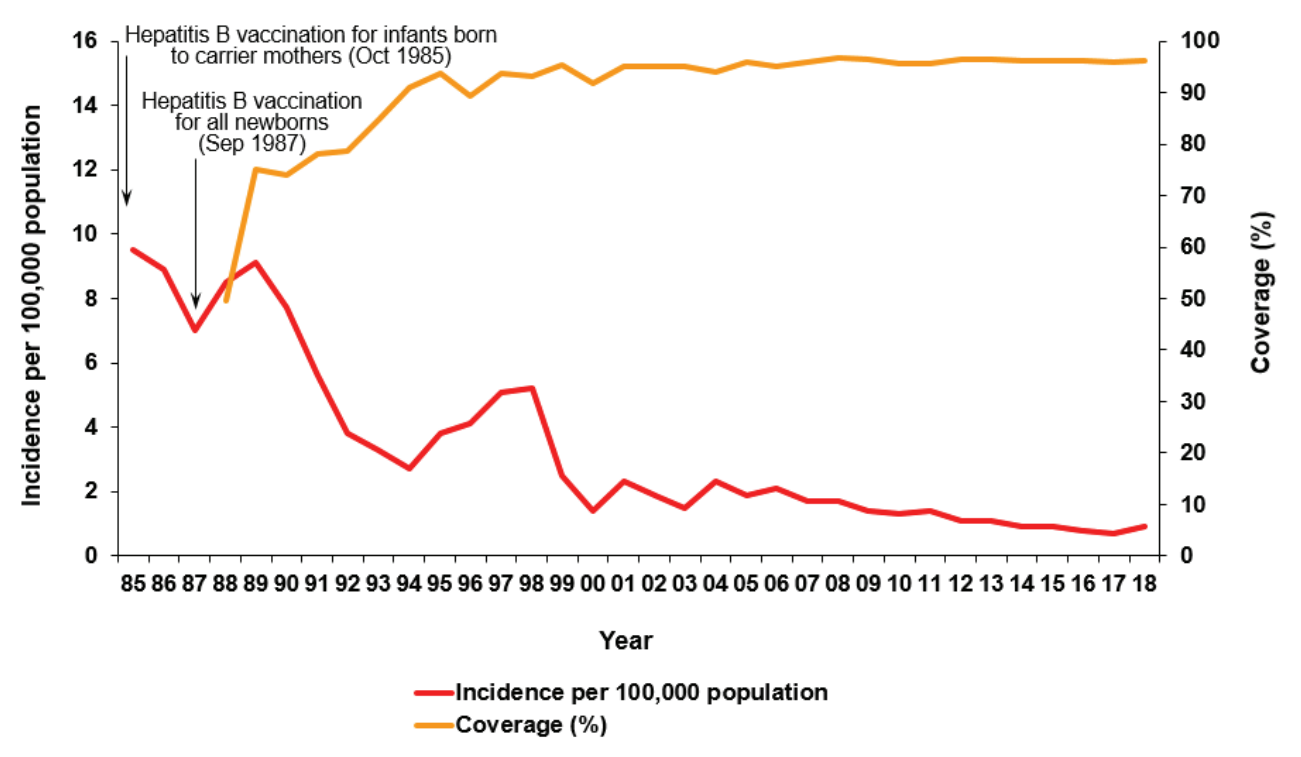
The resurgence of mumps which began in 1998 continued till 2002. The resurgence was due to poor protection conferred by the Rubini strain of the MMR vaccine which was subsequently de-registered in 1999. The number of reported cases of mumps remained largely unchanged in recent years; there were 540 cases in 2016, 524 cases in 2017 and 474 cases in 2018 (Table 7.13).

Table 7.12
No. of therapeutic abortions performed for rubella infection, 2009-2018

Year	Total no. of abortions	No. of therapeutic abortions performed for rubella infections
2009	12,316	0
2010	12,082	0
2011	11,940	0
2012	10,624	1
2013	9,282	2
2014	8,515	0
2015	7,942	1
2016	7,217	0
2017	6,815	2
2018	6,319	2

The incidence of acute hepatitis B cases for all age groups declined from 9.5 cases per 100,000 population in 1985 to 0.9 cases per 100,000 population in 2018 (Figure 7.4). There has been no indigenous case among children <15 years since 1996 (Table 7.13).

Figure 7.4
Incidence of reported acute hepatitis B cases and vaccination coverage in Singapore, 1985-2018



A national seroprevalence survey (NSS) was conducted in 2018 to determine the prevalence of antibodies against vaccine preventable diseases and other diseases of public health importance in the adult Singapore resident population aged 18-74 years using residual sera from the National Population Health Survey (NPHS) 2016/17 Pilot. The data from NSS 2018 is indicative as the sample size of the NPHS Pilot is relatively smaller, compared to the full-scale NPHS. The age-standardised prevalence of antibodies to measles among adult residents in Singapore was 99.3%, compared to 96.7% in NSS 2005. The overall seroprevalence was 90.8% for rubella in those aged 18-74 years. 100% of females aged 18-29 years were seropositive, while 4.4% of females in the 30-49 age group remained susceptible to rubella infection. This was a decrease compared to 17.2% among women females aged 30-49 years in NSS 2012. For Hepatitis B, the age-standardised prevalence of anti-HBs (≥10 mIU/mL) among Singapore residents was 45.8%, which was not significantly different from that in NSS 2012 (43.3%). The overall prevalence of hepatitis B surface antigen (HBsAg) was 2.1%, compared to 3.6% in NSS 2012.

Table 7.13
Reported cases of diphtheria, poliomyelitis, measles, mumps, rubella, acute hepatitis B, neonatal tetanus, pertussis, congenital rubella, and childhood tuberculous meningitis in Singapore, 1989-2018

Year	Diphtheria	Poliomyelitis	Measles	Mumps*	Rubella*	Acute hepatitis B†	Neonatal tetanus‡	Pertussis§	Congenital rubella¶	Childhood tuberculous meningitis#
1989	1(1)	0	146	-	-	4	0	1††	2	0
1990	1	1(1)	143	-	-	1	0	8‡‡	4	0
1991	1(1)	0	216	636	51	3	0	5††	1	0
1992	1	0	606	1,981	370	3	0	14††	4	0
1993	0	0	665	1,962	423	2	0	1††	4	0
1994	0	0	159	1,636	299	2	1	2††	2	0
1995	0	0	185	786	326	0	0	1††	2‡	2‡
1996	1(1)	0	308	765	487	3	0	4(1)‡‡	2‡	2‡
1997	0	0	1,413	674	360	0	0	2††	0‡	2‡
1998	0	0	114	1,183	179	0	0	1**	0‡	0
1999	0	0	65††	6,384(28)	432	0	0	1††	2‡	1‡
2000	0	0	141††	5,981**	312**	0	0	2(1)‡‡	0	1‡
2001	0	0	61††	1,399**	242**	0	0	1**	2‡	0
2002	0	0	57††	1,090**	152**	0	0	0	1	1
2003	0	0	33††	878**	88**	0	0	1‡‡	0	0
2004	0	0	96††	1,003**	141**	0	0	1‡‡	0	0
2005	0	0	33††	1,004**	139**	0	0	2††	1	0
2006	0	1(1)§§	28††	844**	90**	0	0	3‡‡	0	0
2007	0	0	15††	780**	83**	0	0	38††	0	0
2008	0	0	18††	801**	180**	0	0	33††	2	0
2009	0	0	13††	631**	178**	0	0	13	0	0
2010	0	0	49††	452‡‡	158‡‡	0	0	8††	2§§	2
2011	0	0	148††	501‡‡	110‡‡	0	0	29††	2	0
2012	0	0	38††	521‡‡	64‡‡	0	0	24††	2§§	0
2013	0	0	46††	495‡‡	48‡‡	0	0	17††	1§§	0
2014	0	0	148††	478‡‡	17‡‡	0	0	21††	0	0
2015	0	0	42††	473‡‡	15‡‡	0	0	57††	0	0
2016	0	0	126††	540‡‡	10‡‡	0	0	82††	0	0
2017	1	0	70††	524‡‡	15††	0	0	79††	0	0
2018	0	0	34††	474‡‡	10††	0	0	108††	0	0

( ) Imported cases.
* Notifiable with effect from April 1990.
† Indigenous cases below 15 years of age.
‡ Source: Central Claims Processing System, Ministry of Health.
§ All pertussis cases reported prior to 1986 were based on clinically diagnosed cases seen at the Communicable Disease Centre.
¶ Cases diagnosed in KK Women's and Children's Hospital, Singapore General Hospital and National University Hospital.
# Below 10 years of age.
** Based on clinically diagnosed cases.
†† Based on laboratory confirmed cases.
‡‡ Based on laboratory confirmed and clinically diagnosed cases.
§§ Foreigner who came for treatment

PUBLIC EDUCATION

HPB educates parents on the importance of childhood immunisations through educational materials. Under the Healthier Child, Brighter Future initiative, the “Healthy Start For Your Baby” guide also contains a chapter on childhood immunisations. This educates parents on the importance of immunisation and to have their children vaccinated according to the National Childhood Immunisation Schedule. This guidebook is distributed to new mothers before they are discharged from the maternity hospital following delivery. Parents can also visit the HealthHub website (https://www.healthhub.sg/) for more information. NIR also sends a pamphlet “Protect your child from infectious diseases, Get them vaccinated” together with reminder letters to parents whose child have missed vaccinations.

For the general population, HPB implements the social hygiene campaign titled the F.I.G.H.T. campaign which encourages the public to take preventive measures such as going for vaccination. The campaign also encourages the public to wash their hands with soap and water regularly, go to the doctor if they are unwell, rest at home and use tissues and wear masks when they have respiratory infections such as the flu. The campaign includes advertising and activations (e.g. matching board games) carried out island-wide such as in Health Promoting Malls and partners’ events where participants receive F.I.G.H.T collaterals to reinforce the preventive measures.

In addition, HPB runs social posts on immunisation during the World Immunisation Week which falls on the last week of April every year. These social posts remind the public to get the necessary vaccinations.

ACKNOWLEDGEMENT

The Ministry of Health would like to thank medical practitioners, laboratory personnel, nurses, public health professionals, as well as partners from public and private healthcare institutions and other government agencies, who have, in one way or another, contributed to the data and information reported in this publication. We acknowledge their valuable contributions towards our national efforts in communicable diseases surveillance, prevention and control, and look forward to their continued support and cooperation in our work.

We also gratefully acknowledge the many contributions to communicable diseases surveillance in the Ministry of Health from our colleagues in the following allied institutions: National Public Health Laboratory, National Public Health Unit, National Centre for Infectious Diseases, National Environment Agency, Singapore Food Agency, Changi General Hospital, Khoo Teck Puat Hospital, National University Hospital, Ng Teng Fong General Hospital, Sengkang General Hospital, Singapore General Hospital, Tan Tock Seng Hospital, Department of STI Control, National Skin Centre, STEP Registry, TB Control Unit, National Immunisation Registry, and School Health Services, Health Promotion Board.

In addition, we thank all who have contributed their subject matter expertise to the various chapters of this annual report and more importantly, through their untiring professional efforts, helped to maintain Singapore's high standards of epidemiological surveillance, investigation and risk assessment. Without them, this publication would certainly not have been possible.

Editorial Committee 2018

MINISTRY OF HEALTH
SINGAPORE

16 College Road
College of Medicine Building
Singapore 169854