Communicable Diseases Surveillance SINGAPORE 2017

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Contents

FOREWORD

Communicable diseases refer to a host of illnesses caused by microbial agents that can be spread directly or indirectly from one person to another. For effective prevention and control of communicable diseases in a dense populated city state like Singapore, surveillance is key. I am pleased to present the Ministry of Health's report entitled, "Communicable Diseases Surveillance, Singapore 2017"

The information gathered in this report has been made possible through Singapore's comprehensive and well established system of surveillance, epidemiology and response that is resident in the Ministry of Health. This publication aims to serve as an easy reference on communicable diseases for use by the medical and public health community. Our readership includes physicians, epidemiologists, microbiologists, laboratorians, journalists, academics, scientists and public health administrators.

With many public health concerns making headline news in 2017, we have been working hard to safeguard health and wellbeing in our community. Besides providing an overview of the communicable diseases situation in Singapore, this report gives comprehensive coverage of specific notifiable diseases of public health importance that are air/droplet-borne, vector-borne, food-borne, blood-borne and borne by other routes. There is also a section on evaluation of childhood immunisation.

Vigilance in monitoring diseases is crucial for public health. Throughout the year, we carried out epidemiological surveillance to monitor the disease situation, pick up early outbreaks, and formulate and evaluate control strategies. Surveillance has also helped to identify secular disease trends, understand their epidemiology and guide public health policy. We also published the reporting guidelines on infectious diseases clusters for long term care institutions which aims to guide service providers in reporting infectious diseases clusters to the Ministry.

In August 2017, we investigated a fatal autochthonous diphtheria case in a migrant worker. This incident highlighted the risks for individual cases in under-vaccinated risk groups despite high vaccination coverage in the general population. Prompt implementation of public health measures and maintaining immunisation coverage are critical to prevent re-emergence of diphtheria.

The Ministry of Health would like to thank all healthcare professionals and our partner agencies for their support and dedication in combating and minimising the threats of communicable diseases, for the common goal of safeguarding public health.

We look forward to your continued support and cooperation.

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 2017 and an evaluation of our national childhood immunisation programme.

POPULATION PROFILE

In 2017, Singapore had an estimated population of 5.61 million, with a resident population of 3.97 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.

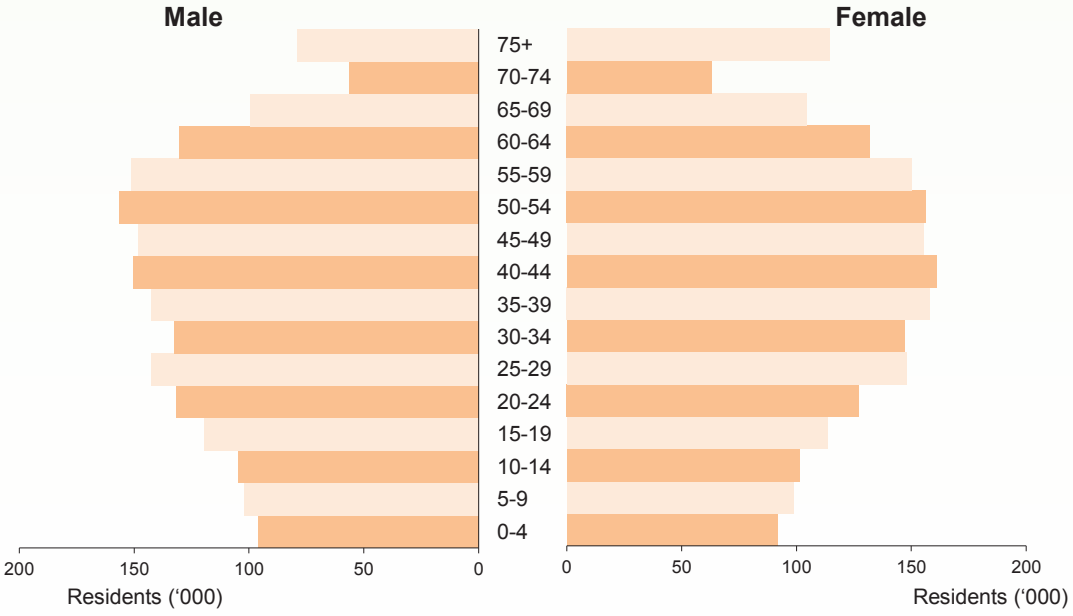
The aging pattern of Singapore's population is shown in the age pyramid below. The proportion of residents aged 15 to 64 years increased from 71% in 1990 to 72% in 2017 while the proportion of children under 15 years has steadily declined from 23% in 1990 to 15% in 2017. Currently 13% of Singapore residents are aged 65 years and above, compared to 6% in 1990.

Demographic profile (mid-year estimates), 2017

Total population	5.61 million
Resident population	3.97 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, 2017



(Source: Singapore Department of Statistics)

COMMUNICABLE DISEASES SITUATION

All notifications of infectious diseases received during the year 2017 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 diphtheria, *haemophilus influenzae* type B disease, hand, foot and mouth disease, influenza, measles, meningococcal infection, mumps, pertussis, pneumococcal disease (invasive), rubella, viral conjunctivitis, and varicella.

There were 33,663 notified cases of hand, foot and mouth disease in 2017, a decrease of 20.1% from 42,154 cases in 2016. A total of 70 measles cases were notified in 2017, compared to 136 cases in 2016. The number of rubella cases reported increased to 15 cases in 2017 compared to 12 cases in 2016. There were also 524 notified cases of mumps in 2017, compared to 540 cases in 2016.

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 2,767 dengue fever/dengue haemorrhagic fever cases were notified in 2017, compared with 13,085 cases in 2016. The majority of the cases were infected locally and dengue virus type 2 was the predominant circulating strain. There were also 29 chikungunya fever cases notified in 2017 compared with 36 cases in 2016.

A total of 67 Zika virus infection were notified in 2017 compared with 458 cases in 2016, where Singapore identified its first imported case of Zika virus infection 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 39 notified cases of malaria in 2017; all had acquired the infection overseas.

Food-borne diseases

The diseases covered in Chapter 4 include acute diarrhoeal illness, 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. These measures were carried out by the Ministry of Health in close collaboration with the National Environment Agency and the Agri-Food and Veterinary Authority of Singapore.

Campylobacteriosis and non-typhoidal salmonellosis contributed significantly to the burden of food-borne illness. There were 495 cases of campylobacteriosis and 2,010 cases of salmonellosis reported in 2017.

The incidence of enteric fevers (typhoid and paratyphoid) showed a 15.7% increase from 70 cases in 2016 to 81 cases in 2017. There were 81 cases of acute hepatitis A notified in 2017, an increase of 68.8% compared to 48 cases in 2016.

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 2017 were chlamydia, gonorrhoea and syphilis. The overall incidence rate of these three STIs was 202 cases per 100,000 population. Chlamydia was the most common infection with an incidence rate of 52.0 cases per 100,000 population.

The number of HIV/AIDS infection notifications was 434 in 2017 compared with 408 in 2016.

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 2017 a total of 2,191 new cases of TB were reported. They comprised 1,536 Singapore residents and 655 long staying foreigners. This represented a decrease of 5.2% from 2016.

There were 19 cases of legionellosis and 52 cases of melioidosis notified in 2017.

Childhood immunisation

Chapter 7 provides the summary of the implementation of the National Childhood Immunisation Programme in 2017. 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 1998-2017 (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 2017

Diseases	No. of notified cases	No. of deaths+	Morbidity rate*	Mortality rate*
Air/Droplet-borne Diseases				
Hand, Foot and Mouth Disease	33,663	0	599.8	0
Measles	70	0	1.2	0
Meningococcal Infection	12	0	0.2	0
Mumps	524	0	9.3	0
Rubella	15	0	0.3	0
Vector-borne Diseases				
Chikungunya Fever	29	0	0.5	0
Dengue Fever/Dengue Haemorrhagic Fever	2,767	2	49.3	0.04
Malaria	39	0	0.7	0
Zika virus infection	67	0	1.2	0
Food-borne Diseases				
Campylobacteriosis	495	0	8.8	0
Cholera	3	0	0.1	0
Hepatitis A	81	0	1.4	0
Hepatitis E	76	0	1.4	0
Paratyphoid	16	0	0.3	0
Salmonellosis	2,010	0	35.8	0
Typhoid	65	0	1.2	0
Blood-borne and Sexually Transmitted Diseases				
Hepatitis B	38	0	0.7	0
Hepatitis C	22	0	0.4	0
HIV/AIDS**	434	72	10.9	1.8
STIs	11,315	0	201.6	0
Other Diseases				
Tuberculosis***	2,191	25	39.0	0.6
Leprosy	6	0	0.1	0
Legionellosis	19	0	0.3	0
Melioidosis	52	0	0.9	0

+Source: Registry of Births & Deaths.
*Rates per 100,000 population, based on estimated mid-year total population, 2017.
(Source: Singapore Department of Statistics)
** Referred to Singaporeans/PR cases.
*** Referred to Singaporeans/PR cases and long staying foreigners.

INFECTIOUS DISEASE NOTIFICATIONS IN SINGAPORE, 1998-2017

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
										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	0	1
Haemophilus influenzae type b	-	-	1	5	0	3	2	5	4	1	1	4	5	2	1	10	6	3	2	8
Hand, Foot and Mouth Disease	1344	1408	6402	5187	16228	5603	6411	15257	15282	20003	29686	17278	30878	20687	37125	31741	22171	28216	42154	33663
Measles	114	65	141	61	57	33	96	33	28	15	18	13	49	148	38	46	142	42	136	70
Meningococcal infection	-	-	-	4	13	11	7	5	10	5	6	5	7	6	0	3	9	6	5	12
Mumps	1183	6384	5981	1399	1090	878	1003	1004	844	780	801	631	452	501	521	495	478	473	540	524
Pertussis	-	-	-	-	-	-	0	0	3	38	33	13	8	29	24	17	21	57	85	79
Pneumococcal disease (Invasive)	-	-	-	-	-	-	-	-	-	-	-	157	166	148	163	167	147	139	131	158
Rubella	179	432	312	242	152	88	141	139	90	83	180	178	158	110	64	48	17	15	12	15
Varicella	27183	31592	24074	18220	27124	15265	20083	24248	24026	30548	-	-	-	-	-	-	-	-	-	-
Vector-Borne Diseases																				
Chikungunya Fever	-	-	-	-	-	-	-	-	-	-	718	341	26	12	22	1059	182	42	36	29
Dengue fever/Dengue haemorrhagic fever	5258	1355	673	2372	3945	4788	9459	14209	3127	8826	7031	4497	5363	5330	4632	22170	18326	11294	13085	2767
Malaria	405	316	266	229	175	118	152	166	181	155	152	172	190	149	143	111	62	47	31	39
Zika virus infection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	458	67
Food-Borne Diseases																				
Campylobacteriosis	269	343	231	105	50	144	131	241	236	170	177	261	320	372	443	397	435	420	442	495
Cholera	31	11	10	8	2	2	11	1	0	7	1	4	4	2	2	2	2	3	2	3
Enteric fever																				
Typhoid	57	48	80	82	49	32	52	69	60	67	84	69	82	71	84	84	58	49	51	65
Paratyphoid	23	15	21	34	25	9	32	26	23	33	29	28	38	33	57	23	19	27	19	16
Hepatitis A	138	88	77	60	236	55	67	98	146	88	107	89	68	66	108	88	73	50	48	81
Hepatitis E	24	20	17	3	24	17	24	36	31	35	54	90	112	97	104	55	68	59	74	76
Salmonellosis	-	-	99	198	129	192	345	296	380	309	719	1144	1480	1374	1499	1735	1920	1988	2212	2010
Blood-Borne & Sexually Transmitted Diseases																				
Hepatitis B	205	140	117	80	63	64	98	83	96	79	87	69	65	73	58	57	48	52	47	38
Hepatitis C	-	-	-	-	-	-	3	26	35	17	13	5	6	3	2	2	5	46	24	22
HIV/AIDS*	199	206	226	237	234	242	311	317	359	423	456	463	441	461	469	454	456	455	408	434
Sexually Transmitted Infections	6258	6318	6251	6686	6891	8173	10697	11048	10989	11523	12280	11381	10742	11159	10869	10347	10183	10318	10767	11315
Other Diseases																				
Legionellosis	37	79	65	52	40	46	17	21	19	16	25	22	25	21	31	24	37	17	12	19
Leprosy	19	22	18	14	11	11	14	13	12	12	10	8	13	16	15	12	6	3	7	6
Melioidosis	114	81	77	59	34	44	98	78	62	61	62	40	60	34	31	36	34	42	58	52
Tuberculosis **	1810	1543	1518	1474	1702	1684	1578	1586	1581	1608	1951	1966	2028	2126	2203	2028	2018	2000	2310	2191

* Refers to Singaporeans/PR cases

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

INFECTIOUS DISEASE NOTIFICATIONS IN SINGAPORE, 1998-2017(cont'd)

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
										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	0.0
Haemophilus influenzae type b	-	-	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.1	0.1	0.0	0.1
Hand, Foot and Mouth Disease	34.2	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
Measles	2.9	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
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	0.1	0.2	0.1	0.1	0.2
Mumps	30.1	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
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
Pneumococcal disease (Invasive)	-	-	-	-	-	-	-	-	-	-	-	3.1	3.3	2.9	3.1	3.1	2.7	2.5	2.3	2.8
Rubella	4.6	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
Varicella	692.2	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
Dengue fever/Dengue haemorrhagic fever	133.9	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
Malaria	10.3	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
Zika virus infection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.2	1.2
Food-Borne Diseases																				
Campylobacteriosis	6.8	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
Cholera	0.8	0.3	0.2	0.2	0.0	0.0	0.3	0.0	0.0	0.2	0.0	0.1	0.1	0.04	0.0	0.0	0.0	0.1	0.0	0.1
Enteric fever																				
Typhoid	1.5	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
Paratyphoid	0.6	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
Hepatitis A	3.5	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
Hepatitis E	0.6	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
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
Blood-Borne & Sexually Transmitted Diseases																				
Hepatitis B	5.2	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
Hepatitis C	-	-	-	-	-	-	0.1	0.6	0.8	0.4	0.3	0.1	0.1	0.1	0.0	0.0	0.1	0.8	0.4	0.4
HIV/AIDS	6.3	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
Sexually Transmitted Infections	159.4	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
Other Diseases																				
Legionellosis	0.9	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
Leprosy	0.5	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	0.1	0.1
Melioidosis	2.9	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
Tuberculosis	56.9	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

CHAPTER 2

AIR/DROPLET-BORNE DISEASES

Droplets can be formed when a person coughs, sneezes or talks. Droplets can also be formed during administration of drugs via nebulizer or invasive procedures such as suctioning and bronchoscopy. 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.

DIPHTHERIA

Diphtheria is an infection caused by *Corynebacterium diphtheriae* and is characterized by sore throat, fever, neck pain, cervical lymphadenopathy, and a thick greyish pseudomembrane on the tonsils. The mode of transmission is through close contact with the nasopharyngeal secretions of an infected person.

There was one indigenous case of diphtheria reported in 2017 involving a 23-year-old Bangladeshi national who worked as a construction worker in Singapore. He was admitted to Khoo Teck Puat Hospital after developing a fever with neck pain on 30 July 2017. He was immediately isolated and started on antibiotic and antitoxin treatment. However, his condition deteriorated rapidly and he passed away 48 hours after admission. Samples of tonsillar and pharyngeal tissue from the case subsequently tested positive for *Corynebacterium diphtheriae*.

HAEMOPHILUS INFLUENZAE TYPE B DISEASE

Haemophilus influenzae type b (Hib) is a gram-negative coccobacillus bacterium 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 2017, there were eight cases of Hib disease reported compared to two cases in 2016 (Figure 2.1). All cases were laboratory-confirmed with positive blood cultures. The age range was 2 to 80 years, and there was an equal ratio of males to females (Table 2.1). Among the three major ethnic groups, Malays had the highest incidence rate, followed by Indians and Chinese (Table 2.2). All were classified as indigenous cases (Table 2.3).

Figure 2.1
Weekly distribution of reported Hib cases, 2016-2017

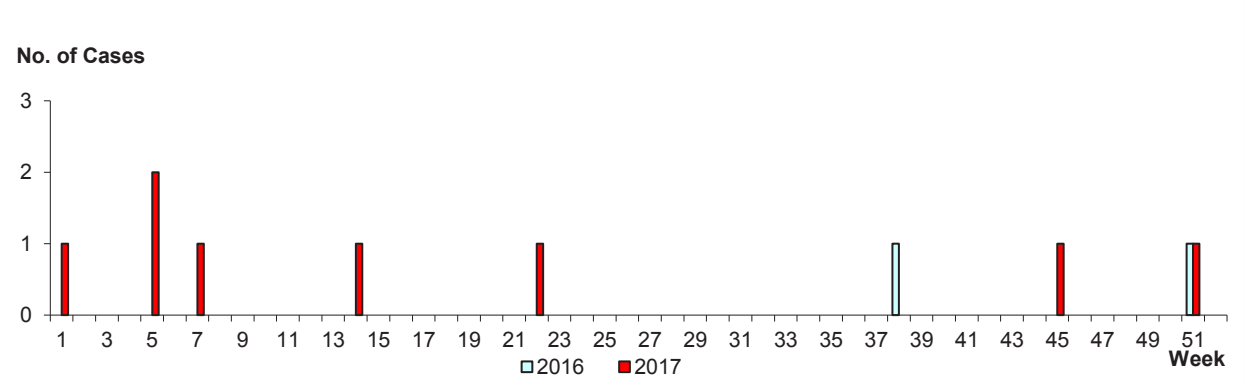


Table 2.1
Age-gender distribution and age-specific resident incidence rate of reported Hib cases, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	1	0	1	12.5	0.5
5-14	0	0	0	0	0
15-24	0	1	1	12.5	0
25-34	1	1	2	25.0	0.2
35-44	0	1	1	12.5	0.2
45-54	0	0	0	0	0
55-64	0	0	0	0	0
65+	2	1	3	37.5	0.6
Total	**4**	**4**	**8**	**100**	

*Rates are based on 2017 estimated mid-year resident population.
(Source: Singapore Department of Statistics)

Table 2.2
Ethnic-gender distribution and ethnic-specific incidence rate of reported Hib cases, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	1	1	2	25.0	0.1
Malay	2	2	4	50.0	0.8
Indian	0	1	1	12.5	0.3
Others	0	0	0	0	0
Foreigners	1	0	1	12.5	0.1
Total	**4**	**4**	**8**	**100**	**0.1**

*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.3
Age-gender distribution and age-specific incidence rate of reported Hib cases, 2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	1	0	0	0	1	0	1	0
5-14	0	0	0	1	0	0	0	0	0	0
15-24	0	0	0	0	0	0	0	0	1	0
25-34	0	0	1	0	0	0	0	0	2	0
35-44	0	0	0	0	0	0	0	0	1	0
45-54	2	0	1	0	0	0	0	0	0	0
55-64	3	1	0	0	0	0	1	0	0	0
65+	4	0	2	0	3	0	0	0	3	0
Total	**9**	**1**	**5**	**1**	**3**	**0**	**2**	**0**	**8**	**0**

^Excluded tourists and foreigners seeking medical treatment in Singapore.

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 33,663 cases of HFMD were reported in 2017. This represented a decrease of 20.1% compared to the 42,154 cases reported in 2016 (Figure 2.2). There were no deaths or cases with severe complications due to HFMD reported in 2017.

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 (22.0%), and EV-A71 (3.7%) were EV-A71. Among the coxsackieviruses type A, CA6 (54.0%) was the predominant serotype, followed by CA10 (19.7%) and CA16 (8.3%).

Figure 2.2
Weekly distribution of reported HFMD cases, 2016-2017

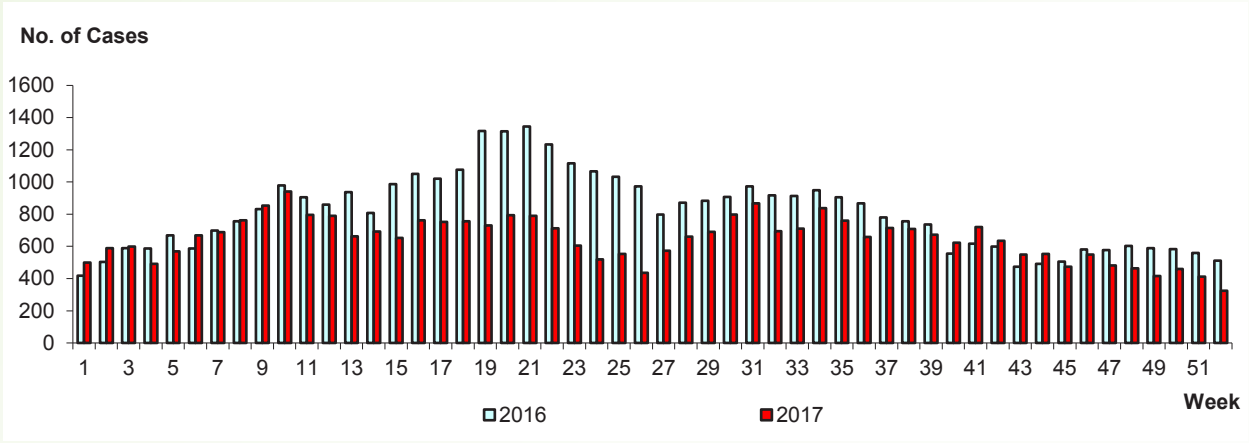


Table 2.4
Age-gender distribution and age-specific resident incidence rate of reported HFMD^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	12,285	9,955	22,240	66.1	10, 512.5
5-14	4,053	3,130	7,183	21.3	1,620.3
15-24	639	571	1,210	3.6	224.2
25-34	674	776	1,450	4.3	221.6
35-44	665	564	1,229	3.7	187.4
45-54	148	101	249	0.7	36.6
55+	39	45	84	0.3	11.9
Total	**18,503**	**15,142**	**33,645**	**100**	

^ Excluded 17 tourists and one foreigner seeking medical treatment in Singapore
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.5
Ethnic-gender distribution and ethnic-specific incidence rate of reported HFMD^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	12,411	10,098	22,509	66.9	763.5
Malay	2,617	2,236	4,853	14.4	914.4
Indian	654	545	1,199	3.6	334.1
Others	883	699	1,582	4.7	1235.8
Foreigners	1,938	1,564	3,502	10.4	212.7
Total	**18,503**	**15,142**	**33,645**	**100**	**599.5**

^ Excluded 17 tourists and one foreigner seeking medical treatment in Singapore
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Institutional outbreaks

There were 1,808 reported outbreaks of HFMD in 2017, each involving two or more cases. Table 2.6 gives a breakdown of HFMD outbreaks at various educational institutions by attack rate.

“pre-school” - various pre-school educational institutions.

Table 2.6
Outbreaks of HFMD in childcare centres/kindergartens, 2017

Attack rate (%)	Childcare centres	Kindergartens
<10	1,231	307
10-20	193	17
21-30	45	1
31-40	10	-
41-50	3	-
>50	1	-
Total	**1,483**	**325**

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.

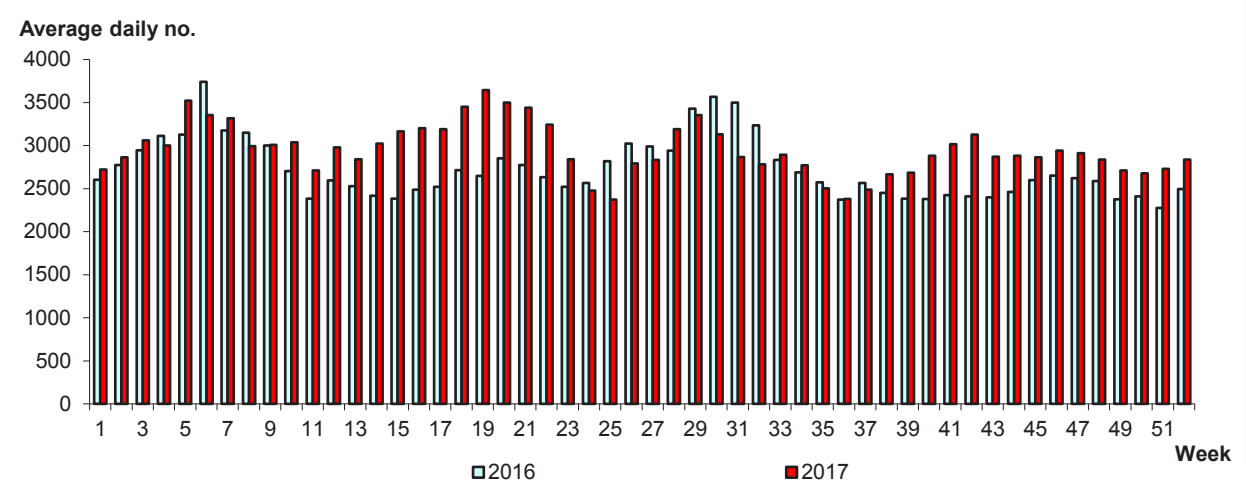
There are three main types – Type A, Type B and Type C. Influenza A (H1N1)pdm09, influenza A(H3N2) and influenza B are influenza viruses commonly circulating globally and in the community. Influenza C is associated with mild sporadic illness and occurs less frequently. Diagnosis is based on the clinical 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 hospital 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.

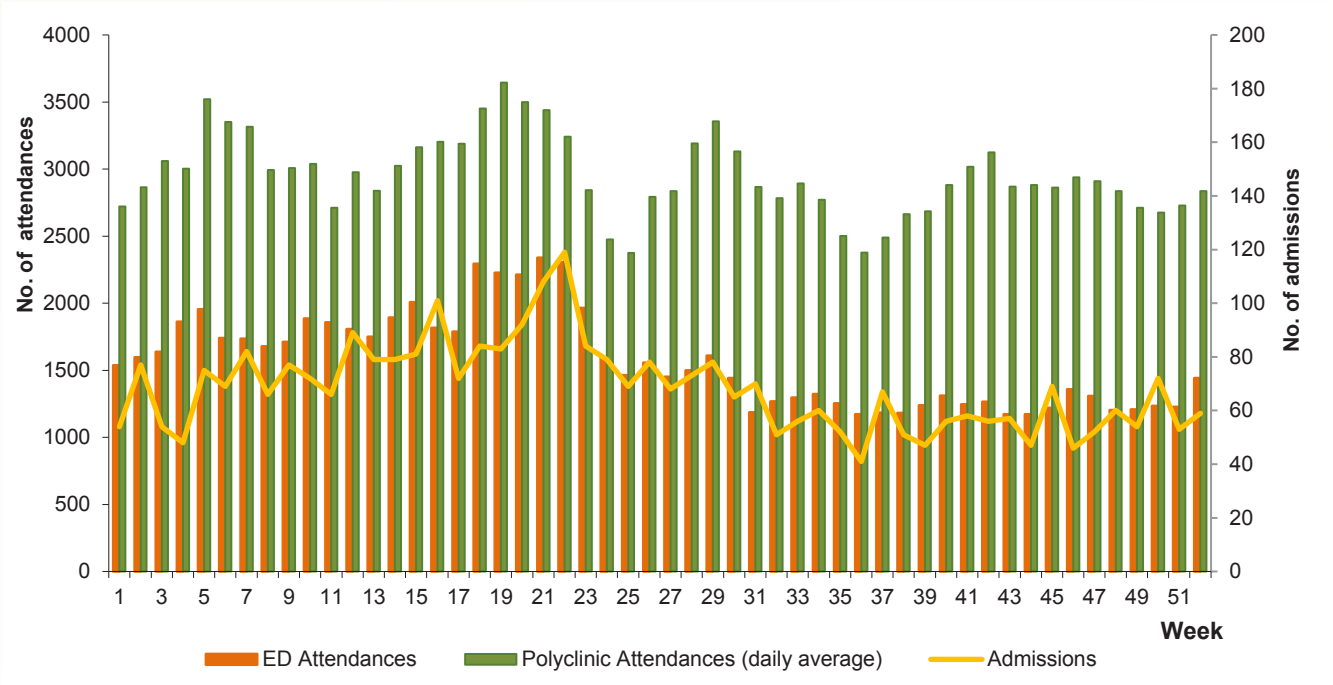
There were a total of 812,571 attendances at polyclinics for ARI in 2017, representing an increase of 7.9% compared to 753,167 seen in 2016. No clear seasonal pattern for ARI was observed (Figure 2.3).

Figure 2.3
Weekly distribution of ARI attendances at polyclinics, 2016-2017



A total of 81,687 ARI cases were seen at the emergency departments (ED) of public hospitals in 2017, a decrease of 7.3% compared to 88,099 cases reported in 2016. Of these 81,687 ARI cases, 3,555 cases were admitted. This is an increase of 14.5% compared to 3,105 ARI admissions reported in 2016. (Figure 2.4).

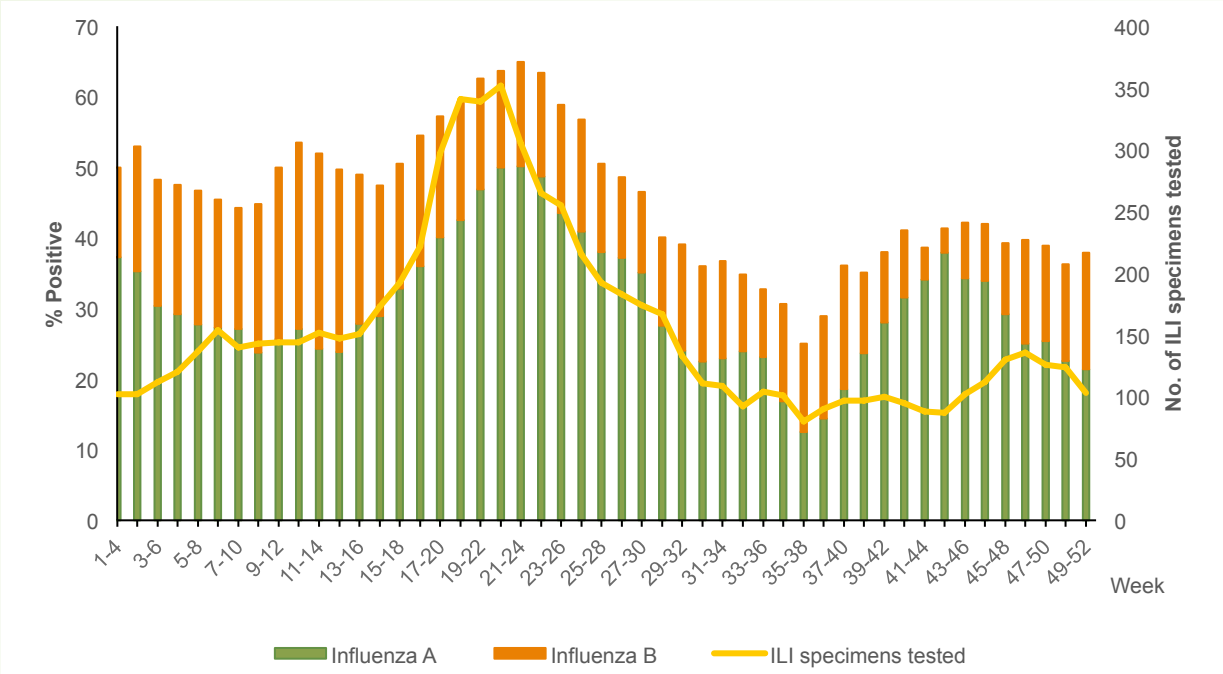
Figure 2.4
Weekly polyclinics attendances,hospitals emergency departments attendances and admissions for acute respiratory infections, 2017



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.

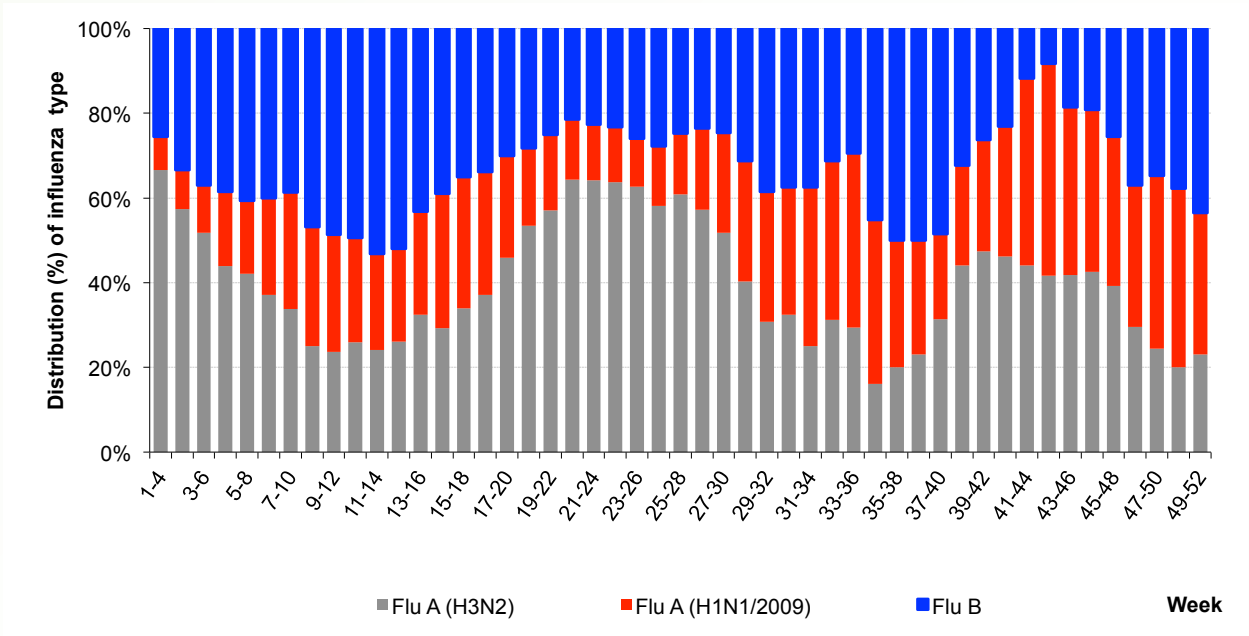
The 4-weekly moving average of the proportion of samples from patients in polyclinics and sentinel GP clinics with influenza-like illness (ILI) which were positive for influenza viruses is shown in Figure 2.5. Higher levels of influenza activity were observed for the 4-weekly moving average between E-weeks 17-20 and 24-27, with a range of 56.7% to 63.6%.

Figure 2.5
Virological surveillance of influenza A & B, 2017



In 2017, 35.6% of all ILI samples tested positive for influenza viruses. Of the positive samples, 68.6% tested positive for influenza A viruses, of which 66.3% were of the influenza A(H3N2) 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, 2017 (Figure 2.6).

Figure 2.6
Influenza typing results, 2017



In 2017, influenza A(H1N1)pdm09 viruses from phylogenetic clade 6B.1 dominated and were antigenically related to the current vaccine strain, A/Michigan/45/2014. Similar to worldwide trends, influenza A(H3N2) viruses continued to diversify genetically. All viruses were grouped within the major phylogenetic clade 3C.2a represented by the vaccine strain A/Hong Kong/4801/2014 (Southern hemisphere 2018 vaccine composition). The majority of A(H3N2) viruses in Singapore could be further classified into the emerging 3c.2a1 subclade and were antigenically related to the currently recommended vaccine strain A/Singapore/INFIMH-16-0019/2016 (SH2018). Among the circulating influenza B viruses, viruses from the B/Yamagata/16/88 lineage dominated significantly over viruses from the B/Victoria/2/87 lineage.

Viruses belonging to B/Victoria/2/87 lineage fell within phylogenetic clade 1A and remain antigenically similar to B/Brisbane/60/2008. Viruses belonging to B/Yamagata/16/88 lineage were antigenically similar to B/Phuket/3073/2013, which is recommended in the quadrivalent vaccine compositions.

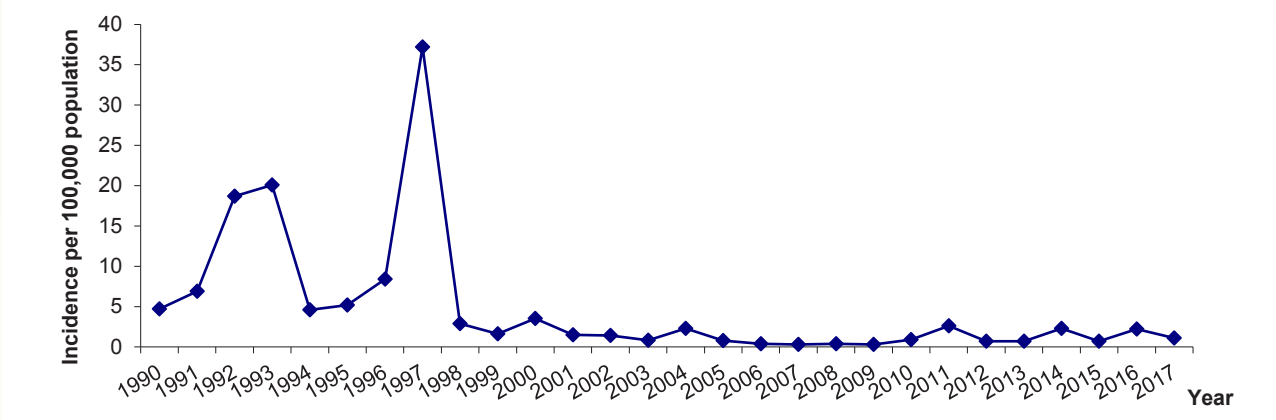
Of the 200 influenza A(H1N1)pdm09, A(H3N2) and B virus isolates that were analysed for resistance to neuramindase inhibitors, only one A(H1N1)pdm09 isolate contained the H275Y mutation which conferred resistance.

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, 1990-2017



A total of 70 laboratory confirmed cases of measles were reported in 2017 compared to 136 cases reported in 2016 (Figure 2.8). Of the 70 confirmed cases, 51 were indigenous cases, eight were imported cases and the remaining 11 involved tourist and foreigners seeking medical treatment in Singapore (Table 2.8). The highest incidence rate was observed in children between six months and less than one year of age (Table 2.9). Among the three major ethnic groups, Malays had the highest incidence rate, followed by Indians and Chinese with the same incidence rate (Table 2.10).

Figure 2.8
Weekly distribution of reported measles cases, 2016-2017

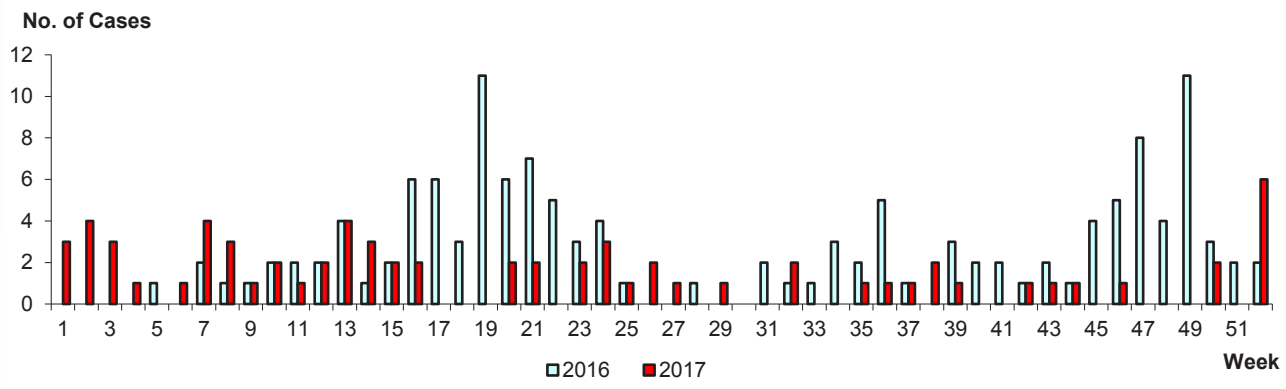


Table 2.8
Total number of notifications* received for measles, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
< 6 mths	2	1	4	0	1	0	10	0	1	0
6 mths-< 1yr	12	3	21	7	9	0	33	2	10	0
1-4	9	5	31	9	6	2	27	3	7	1
5-9	0	4	2	0	1	0	11	0	3	0
10-14	1	0	0	0	1	0	0	0	0	0
15-24	1	0	4	2	2	1	1	0	4	1
25-34	2	0	20	8	4	6	16	1	11	1
35-44	4	0	14	1	5	2	17	2	10	5
45-54	0	0	3	2	0	0	3	0	4	0
55+	0	0	0	0	0	0	0	0	1	0
Total	**31**	**13**	**99**	**29**	**29**	**11**	**118**	**8**	**51**	**8**

*Excluding tourists and foreigners seeking medical treatment in Singapore

Table 2.9
Age-gender distribution and age-specific resident incidence rate of reported measles cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
< 6 mths	1	0	1	1.7	5.3
6 mths-< 1yr	6	4	10	16.9	53.3
1-4	4	4	8	13.6	4.0
5-9	1	2	3	5.1	0.5
10-14	0	0	0	0	0
15-24	3	2	5	8.5	0.4
25-34	6	6	12	20.3	0.8
35-44	8	7	15	25.4	1.5
45-54	2	2	4	6.8	0.5
55+	0	1	1	1.7	0.2
Total	**31**	**28**	**59**	**100**	

^Excluding five tourists and six foreigners seeking medical treatment in Singapore
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.10
Ethnic-gender distribution and ethnic-specific incidence rate of reported measles cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	7	12	19	32.2	0.6
Malay	8	8	16	27.1	3.0
Indian	1	1	2	3.4	0.6
Others	1	1	2	3.4	1.6
Foreigners	14	6	20	33.9	1.2
Total	**31**	**28**	**59**	**100**	**1.1**

^Excluding five tourists and six foreigners seeking medical treatment in Singapore
*Rates are based on 2017 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 2017, there were 12 cases of meningococcal infection reported compared to five cases in 2016 (Tables 2.11 and 2.12). All the cases were laboratory-confirmed with positive blood or cerebral spinal fluid culture. The incidence rate was highest in the 0-4 years age group, and serotype B was implicated in seven cases. (Table 2.13).

Table 2.11
Total number of notifications* received for meningococcal infection, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	1	0	3	0	2	0	0	0	1	1
5-14	0	0	0	0	0	0	0	0	0	0
15-24	0	0	0	0	2	0	2	0	4	0
25-34	0	0	1	0	2	0	1	0	1	0
35-44	0	1	1	0	0	0	0	1	1	0
45-54	0	0	2	0	0	0	0	0	0	0
55-64	1	0	2	0	0	0	0	0	2	0
65+	0	0	0	0	0	0	0	1	2	0
Total	**2**	**1**	**9**	**0**	**6**	**0**	**3**	**2**	**11**	**1**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 2.12
Age-gender distribution and age-specific resident incidence rate of reported meningococcal infection cases, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	2	0	2	16.7	0.9
5-14	0	0	0	0	0
15-24	3	1	4	33.3	0.6
25-34	1	0	1	8.3	0
35-44	1	0	1	8.3	0.1
45-54	0	0	0	0	0
55-64	1	1	2	16.7	0.3
65+	1	1	2	16.7	0.4
Total	**9**	**3**	**12**	**100**	

*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.13
Epidemiological data of 12 reported meningococcal infection cases, 2017

Case particulars				
Gender	**Age**	**Ethnic group**	**Causative agent**	**Status**
M	19 weeks	Indian	*Neisseria meningitidis* Grp W135	Recovered
M	2 years	Malay	*Neisseria meningitidis* Grp B	Recovered
M	19 years	Chinese	*Neisseria meningitidis* Grp Y	Recovered
M	20 years	Chinese	*Neisseria meningitidis* Grp B	Recovered
M	20 years	Chinese	*Neisseria meningitidis* Grp B	Recovered
F	21 years	Malay	*Neisseria meningitidis* Grp B	Recovered
M	30 years	Foreigner	*Neisseria meningitidis* Grp B	Recovered
M	42 years	Chinese	*Neisseria meningitidis* Grp B	Recovered
F	58 years	Indian	*Neisseria meningitidis* Grp B	Recovered
M	59 years	Indian	*Neisseria meningitidis* (non-groupable)	Recovered
M	68 years	Chinese	*Neisseria meningitidis* Grp A/Y	Recovered
F	70 years	Malay	*Neisseria meningitidis* Grp C	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 genus *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, 1990-2017

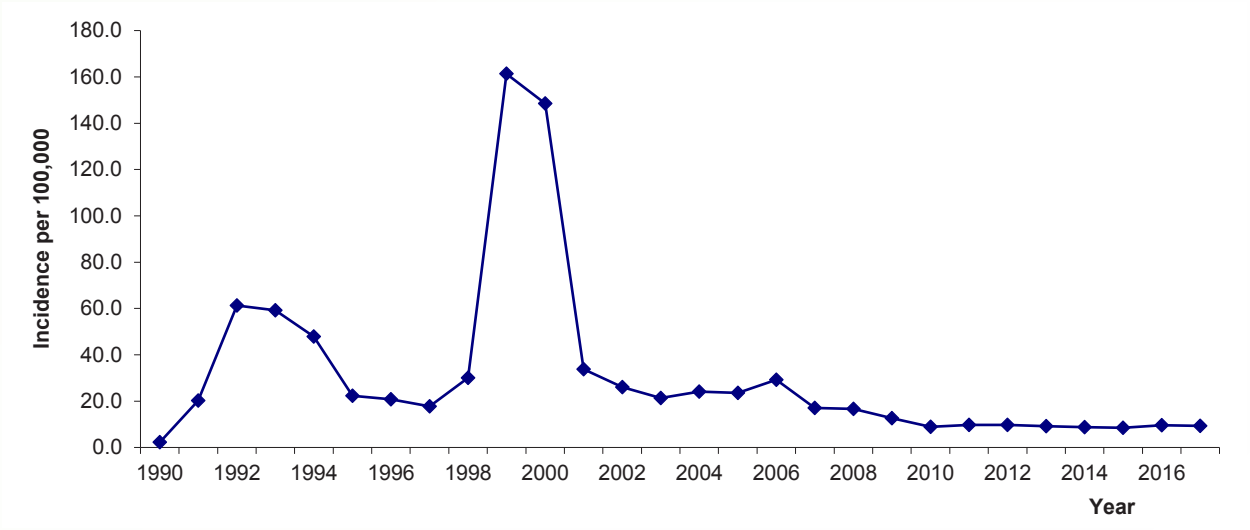
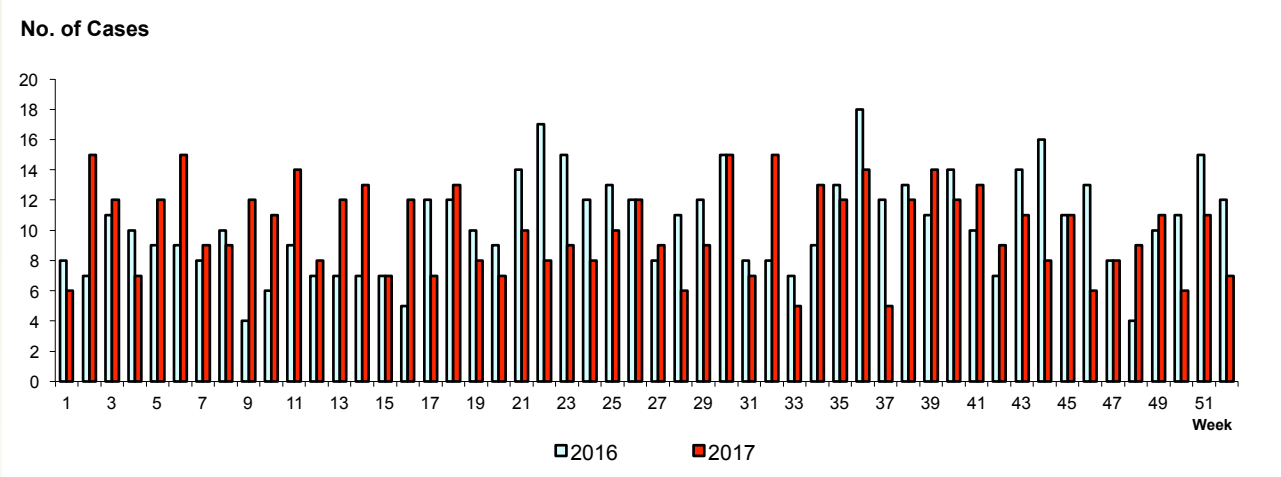


Figure 2.10
Weekly distribution of reported mumps cases, 2016-2017



A total of 524 cases were reported in 2017 as compared to 540 cases in 2016 (Figure 2.10). The incidence rate was highest in the 0-4 years age group (Table 2.14). Among the three major ethnic groups, Malays had the highest incidence rate, followed by Chinese and Indians (Table 2.15).

Table 2.14
Age-gender distribution and age-specific resident incidence rate of reported mumps cases, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	37	30	67	12.8	27.2
5-14	81	55	137	25.9	27.0
15-24	27	18	45	8.6	4.3
25-34	64	35	99	18.9	6.7
35-44	44	25	69	13.2	9.3
45-54	31	28	59	11.3	8.1
55-64	21	10	31	5.9	5.3
65+	8	10	18	3.4	3.1
Total	**313**	**211**	**524**	**100**	

*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.15
Ethnic-gender distribution and ethnic-specific incidence rate of reported mumps cases, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	149	109	258	49.2	8.8
Malay	45	30	75	14.3	14.1
Indian	10	12	22	4.2	6.1
Others	13	4	17	3.2	13.3
Foreigners	96	56	152	29.0	9.2
Total	**313**	**211**	**524**	**100**	**9.3**

*Rates are based on 2017 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 79 laboratory confirmed cases of pertussis were reported in 2017 compared to 85 in 2016 (Figure 2.11). Of the 79 confirmed cases, 76 were indigenous cases and the remaining three were tourist/ foreigners seeking medical treatment. (Table 2.16). The highest incidence rate was observed in children below the age of one year (Table 2.17). Among the three major ethnic groups, Malays had the highest incidence rate, followed by Chinese and Indians (Tables 2.18). One pertussis death was reported in 2017.

Figure 2.11
Weekly distribution of reported pertussis cases, 2016-2017

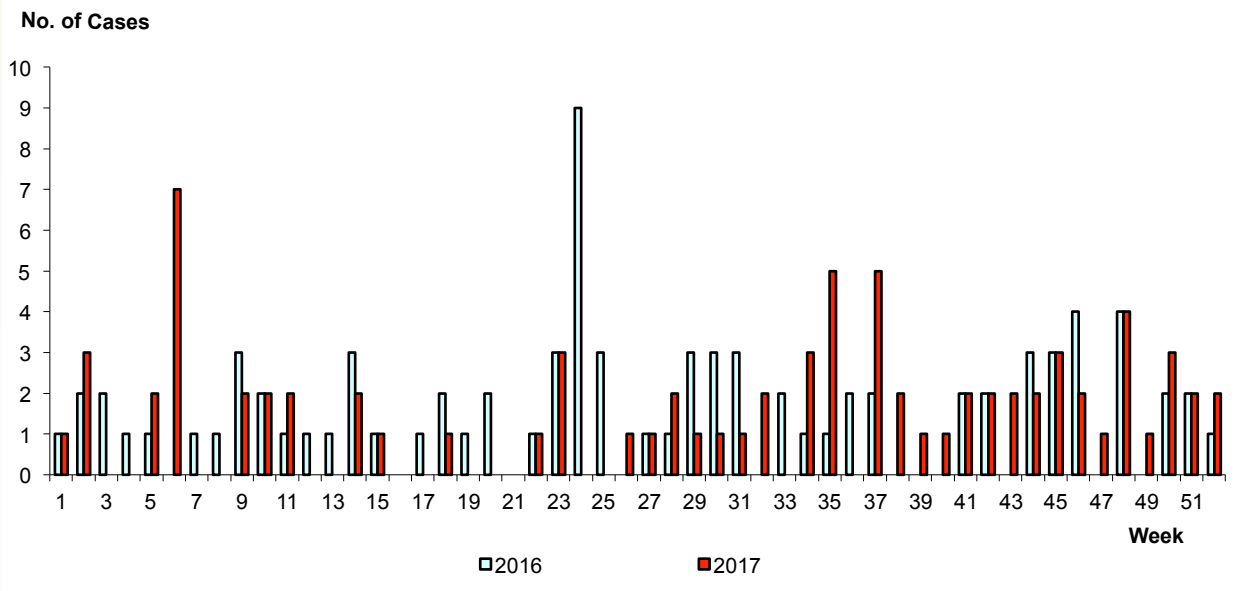


Table 2.16
Total number of notifications* received for pertussis, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	14	1	9	2	47	1	44	2	41	0
5-14	0	0	1	0	0	0	7	0	1	0
15-24	0	1	9	0	7	0	21	0	16	0
25-34	1	0	0	0	0	0	1	0	0	0
35-44	0	0	0	0	0	0	0	1	2	0
45-54	0	0	0	0	1	0	2	1	4	0
55-64	0	0	0	0	1	0	2	0	4	0
65+	0	0	0	0	0	0	3	1	8	0
Total	**15**	**2**	**19**	**2**	**56**	**1**	**80**	**5**	**76**	**0**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 2.17
Age-gender distribution and age-specific resident incidence rate of reported pertussis cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-<1yr	22	18	40	52.6	103.9
1-4	1	0	1	1.3	0.7
5-14	0	1	1	1.3	0.2
15-24	16	0	16	21.1	3.3
25-34	0	0	0	0	0
35-44	1	1	2	2.6	0.3
45-54	2	2	4	5.3	0.6
55-64	3	1	4	5.3	0.7
65+	5	3	8	10.5	1.5
Total	**50**	**26**	**76**	**100**	

^Excluded one tourist and two foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.18
Ethnic-gender distribution and ethnic-specific incidence rate of reported pertussis cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	27	10	37	48.7	1.3
Malay	20	11	31	40.8	5.8
Indian	1	1	2	2.6	0.6
Others	2	3	5	6.6	3.9
Foreigners	0	1	1	1.3	0.1
Total	**50**	**26**	**76**	**100**	**1.4**

^ Excluded one tourist and two foreigners seeking medical treatment in Singapore
*Rates are based on 2017 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 157 laboratory confirmed cases of invasive pneumococcal infection were reported in 2017 compared to 131 cases reported in 2016 (Figure 2.12). Of the 157 confirmed cases, 149 were indigenous cases, seven were imported cases, and one was a foreigner seeking medical treatment (Table 2.19). The incidence rate was highest in the 65 years and above age group (Table 2.20). Among the three major ethnic groups, Malays had the highest incidence rate, followed by Chinese and Indians (Tables 2.21). Of these 157 laboratory confirmed IPD cases, 139 cases were serotyped (88.5%).The predominant pneumococcal types were Type 19A in children and Type 3 in adults. (Tables 2.22 and 2.23).

Figure 2.12
Weekly distribution of reported invasive pneumococcal disease cases, 2016-2017

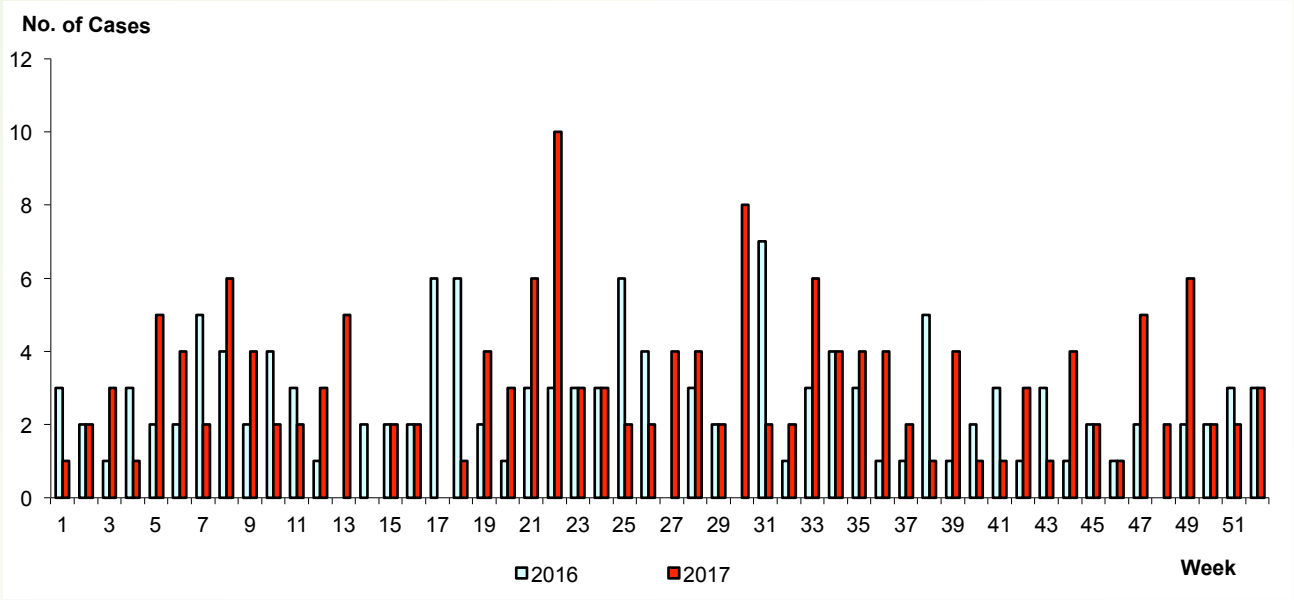


Table 2.19
Total number of notifications* received for invasive pneumococcal disease cases, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	9	1	14	0	10	1	7	2	9	0
5-14	8	1	7	1	9	0	10	0	1	0
15-24	1	1	2	1	4	0	2	0	2	0
25-34	13	3	11	0	9	1	10	1	4	0
35-44	11	0	9	1	11	0	13	1	10	0
45-54	17	1	11	1	15	0	12	1	17	2
55-64	36	0	24	3	25	0	30	0	43	1
65+	64	1	62	0	60	1	41	1	63	4
Total	**159**	**8**	**140**	**7**	**143**	**3**	**125**	**6**	**149**	**7**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 2.20
Age-gender distribution and age-specific resident incidence rate of reported invasive pneumococcal disease cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	5	4	9	5.8	3.9
5-14	0	1	1	0.6	0.2
15-24	1	1	2	1.3	0.2
25-34	1	3	4	2.6	0.5
35-44	6	4	10	6.4	0.8
45-54	14	5	19	12.2	2.8
55-64	31	13	44	28.2	7.3
65+	46	21	67	42.9	13.0
Total	**104**	**52**	**156**	**100**	

^Excluded one foreigner seeking medical treatment in Singapore
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.21
Ethnic-gender distribution and ethnic-specific incidence rate of reported invasive pneumococcal disease cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	69	29	98	62.9	3.3
Malay	19	13	32	20.5	6.0
Indian	6	4	10	6.4	2.8
Others	1	1	2	1.3	1.6
Foreigners	9	5	14	8.9	0.9
Total	**104**	**52**	**156**	**100**	**2.8**

^Excluded one foreigner seeking medical treatment in Singapore
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.22
Distribution of pneumococcal serotypes among children cases, 2017

Pneumococcal Type/ Group	Number of isolates (n = 9) (%)
Type 3 §	1 (11.1)
Group 11	2 (22.2)
Group 15	1 (11.1)
Type 19A §	3 (33.4)
Non-groupable	2 (22.2)

§ Serotype included in PCV13.

Table 2.23
Distribution of pneumococcal serotypes among adult cases, 2017

Pneumococcal Type/ Group	Number of isolates (n = 130) (%)
Type 1 §	2 (1.5)
Type 3 §	23 (17.6)
Type 4 *§	3 (2.3)
Type 6A §	2 (1.5)
Type 6B *§	6 (4.6)
Type 6C	2 (1.5)
Type 7C	1 (0.8)
Type 7F §	5 (3.7)
Type 8	2 (1.5)
Type 9V *§	4 (3.1)
Group 9 (not 9N or 9V)	1 (0.8)
Group 10	4 (3.1)
Group 11	4 (3.1)
Group 12	2 (1.5)
Type 14 *§	10 (7.6)
Type 15A	1 (0.8)
Type 15B	2 (1.5)
Type 15C	3 (2.3)
Type 15F	1 (0.8)
Type 18C *§	1 (0.8)
Type 19A §	10(7.6)
Type 19F *§	4 (3.1)
Group 20	9 (6.8)
Type 22F	1 (0.8)
Type 23A	4 (3.1)
Type 23B	2 (1.5)
Type 23F *§	10 (7.6)
Group 33	2 (1.5)
Non-groupable	9 (6.8)

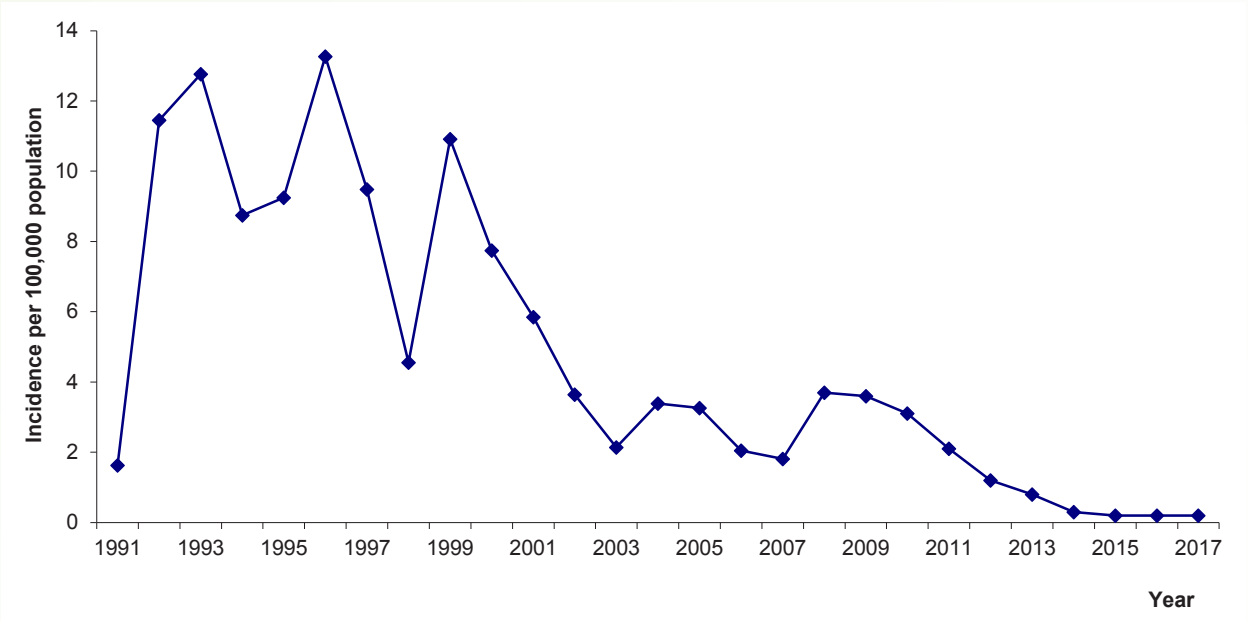
* Serotype included in PCV7
§ Serotype included in PCV13

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 2017 (Figure 2.13).

Figure 2.13
Incidence of reported rubella cases, 1991-2017



A total of 15 laboratory confirmed cases of rubella were reported in 2017, compared to 12 cases reported in 2016 (Figure 2.14). Of the 15 laboratory confirmed cases, eight were indigenous cases, four were imported cases and the remaining three involved tourist/ foreigners seeking medical treatment in Singapore (Table 2.24). The incidence rate was highest in the 25-34 years age group (Table 2.25). Six out of nine female cases were in the reproductive age group of 15-44. Among the three major ethnic groups, Indian had the highest incidence rate, followed by Chinese (Table 2.26). There were no cases of Congenital Rubella Syndrome (CRS) reported to the Ministry of Health in 2017.

Figure 2.14
Weekly distribution of reported rubella cases, 2016-2017

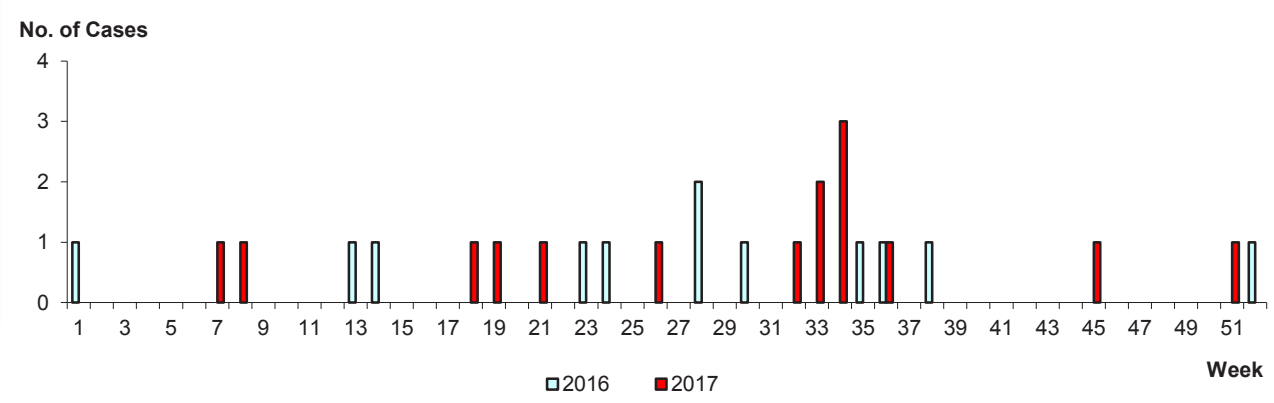


Table 2.24
Total number of notifications* received for rubella, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
< 6 mths	2	0	0	0	1	0	2	0	0	0
6 mths-< 1 yr										
1-4	3	0	5	0	3	0	3	0	0	0
5-9	0	0	1	0	1	0	0	0	0	1
10-14	0	0	1	0	0	0	0	0	0	0
15-24	2	0	0	0	1	0	1	0	2	0
25-34	10	1	3	1	4	0	2	1	4	1
35-44	12	2	2	2	3	0	0	1	1	1
45-54	7	0	0	0	0	0	0	0	1	1
55+	5	0	0	0	0	0	0	0	0	0
Total	**41**	**3**	**12**	**3**	**13**	**0**	**8**	**2**	**8**	**4**

*Excluded tourists and foreigners seeking medical treatment in Singapore

Table 2.25
Age-gender distribution and age-specific resident incidence rate of reported rubella cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	0	1	1	8.3	0
15-24	1	1	2	16.7	0
25-34	2	3	5	41.6	0.4
35-44	0	2	2	16.7	0.2
45-54	0	2	2	16.7	0.2
55+	0	0	0	0	0
Total	**3**	**9**	**12**	**100**	

^Excluded two tourists and one foreigner seeking medical treatment in Singapore
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.26
Ethnic-gender distribution and ethnic-specific incidence rate of reported rubella cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	2	2	4	33.4	0.1
Malay	0	0	0	0	0
Indian	0	1	1	8.3	0.3
Others	1	0	1	8.3	0.8
Foreigners	0	6	6	50.0	0.4
Total	**3**	**9**	**12**	**100**	**0.2**

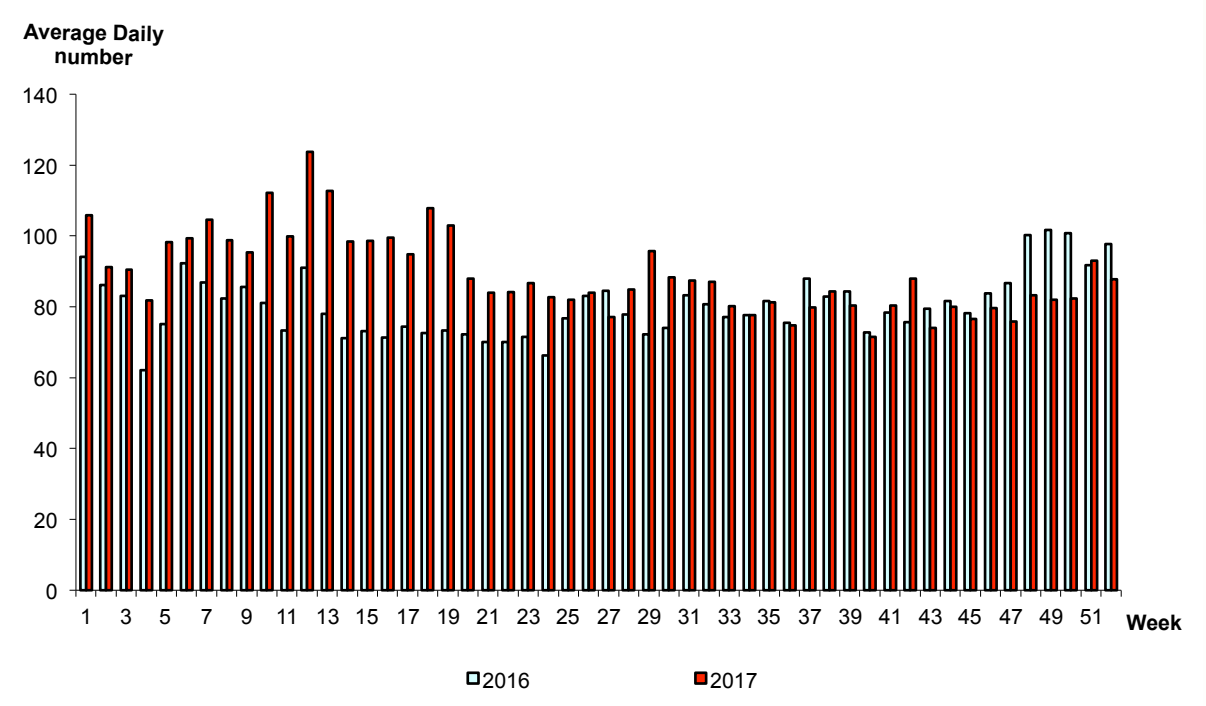
^Excluded two tourists and one foreigners seeking medical treatment in Singapore
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

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 2017, the polyclinics reported 24,545 attendances for conjunctivitis, compared to 22,242 attendances reported in 2016 (Figure 2.15).

Figure 2.15
Weekly distribution of reported conjunctivitis cases, 2016-2017



CHICKENPOX

There were a total of 4,038 attendances in polyclinics for chickenpox in 2017 compared with 3,998 attendances in 2016. 92.7% of the attendances were by Singaporeans and Permanent Residents. Persons below the age of 20 years represented 62.6% of attendances for chickenpox (Table 2.27).

Table 2.27
Distribution of varicella (chickenpox) polyclinic attendances by gender, age group and nationality, 2017

Age group	Singaporeans/PRs			Foreigners			Total	%
	Male	Female	Total	Male	Female	Total		
0-9	779	746	1525	16	17	33	1558	38.5
10-19	512	450	962	6	4	10	972	24.1
20-29	201	194	395	110	36	146	541	13.4
30-39	115	95	210	64	19	83	293	7.3
40-49	124	95	219	15	7	22	241	6.0
50-59	115	72	187	0	3	3	190	4.7
60+	145	97	242	1	0	1	243	6.0
Total	**1,991**	**1,749**	**3,740**	**212**	**86**	**298**	**4,038**	**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 29 laboratory confirmed cases of chikungunya fever were reported in 2017, compared to 36 laboratory-confirmed cases in 2016 (Figure 3.1). Out of the 29 cases, 26 were imported cases, involving nine Singapore residents, eight foreigners including work permit/student pass/dependent pass holders and nine tourists or foreigners seeking medical treatment. The remaining three cases were indigenous cases (Table 3.1). No deaths due to chikungunya were reported in 2017.

Figure 3.1
Weekly distribution of chikungunya fever cases, 2016-2017

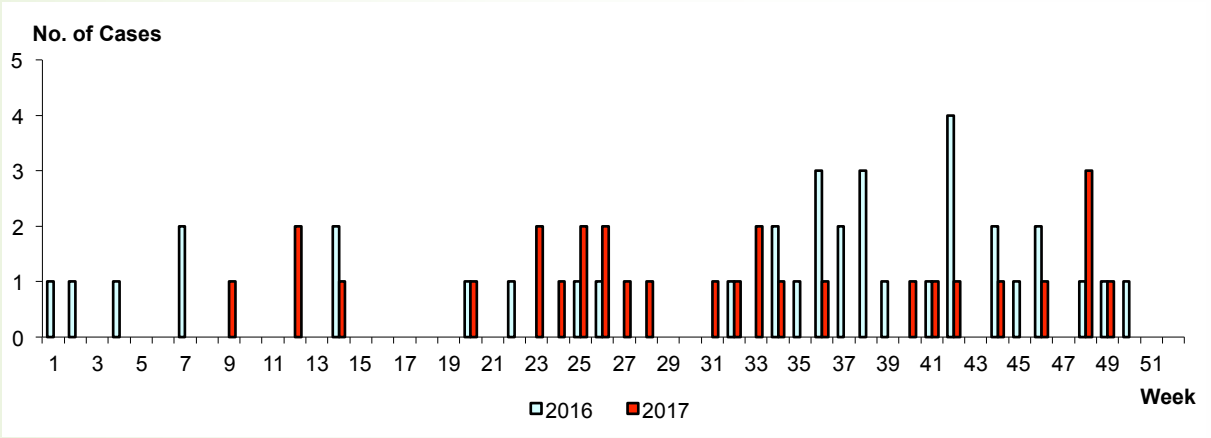


Table 3.1
Total number of notifications* received for chikungunya fever, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	4	0	1	0	0	0	0	0	0	0
5-14	30	2	5	0	0	2	1	0	0	1
15-24	82	2	17	0	0	0	0	1	1	1
25-34	294	8	39	3	5	4	0	7	1	4
35-44	294	17	33	4	3	5	0	12	1	2
45-54	141	4	18	5	1	1	0	6	0	5
55-64	101	4	17	1	1	2	1	1	0	3
65+	65	2	9	2	2	0	0	2	0	1
Total	**1,011**	**39**	**139**	**15**	**12**	**14**	**2**	**29**	**3**	**17**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Of the three indigenous cases, two were males in the 15-24 and 35-44 age groups, and the remaining was a female in the 25-34 years age group (Table 3.2). Among the three major ethnic groups, Indians had the highest incidence rate, followed by Chinese.

Table 3.2
Age-gender distribution and age-specific resident incidence rate of indigenous chikungunya fever cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	1	0	1	33.3	0.1
25-34	0	1	1	33.3	0.1
35-44	1	0	1	33.3	0.1
45-54	0	0	0	0	0
55-64	0	0	0	0	0
65+	0	0	0	0	0
Total	**2**	**1**	**3**	**100**	

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2017 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^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	1	0	1	33.3	0
Malay	0	0	0	0	0
Indian	1	0	1	33.3	0.3
Others	0	1	1	33.3	0.8
Foreigners	0	0	0	0	0
Total	**2**	**1**	**3**	**100**	**0.1**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

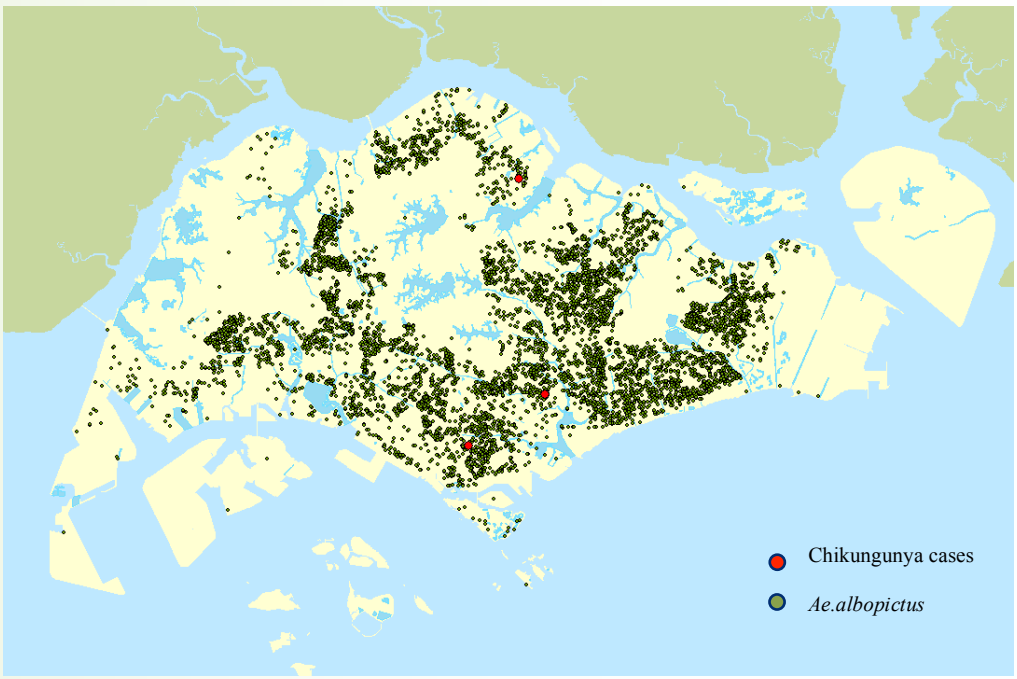
There were 26 (89.7%) imported cases, defined as residents and non-residents with a history of travel to chikungunya-endemic countries within 12 days prior to the onset of illness. Majority (42.3%) had travelled to or came from Bangladesh (Table 3.4).

Table 3.4
Imported chikungunya fever cases, 2013-2017

	Year				
	2013	**2014**	**2015**	**2016**	**2017**
Southeast Asia					
Thailand	2	1	0	0	0
Myanmar	0	0	0	1	0
Malaysia	5	1	0	3	3
Indonesia	15	33	9	3	0
Philippines	7	4	0	4	2
East Timor	0	0	3	0	0
South Asia					
Bangladesh	1	0	0	0	11
India	18	1	15	23	9
Maldives	0	0	0	0	0
Sri Lanka	0	0	1	0	0
Americas	0	2	2	0	1
Europe	0	1	0	0	0
Total	**48**	**43**	**30**	**34**	**26**

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*, 2017



(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 remained low in 2017 as compared to 2016 (Figure 3.3). A total of 2,767 laboratory confirmed cases of dengue (comprising 2,750 cases of DF and 17 cases of DHF) were reported in 2017, a decrease of 78.9% from the 13,085 cases reported in 2016. Out of the 2,767 cases, 249 were imported cases involving 60 Singapore residents and 61 foreigners including work permit/student pass/dependent pass holders and 128 tourists or foreigners seeking medical treatment in Singapore. The remaining 2,518 cases were classified as indigenous cases (Table 3.5).

Figure 3.3
Weekly distribution of DF/DHF cases, 2016-2017

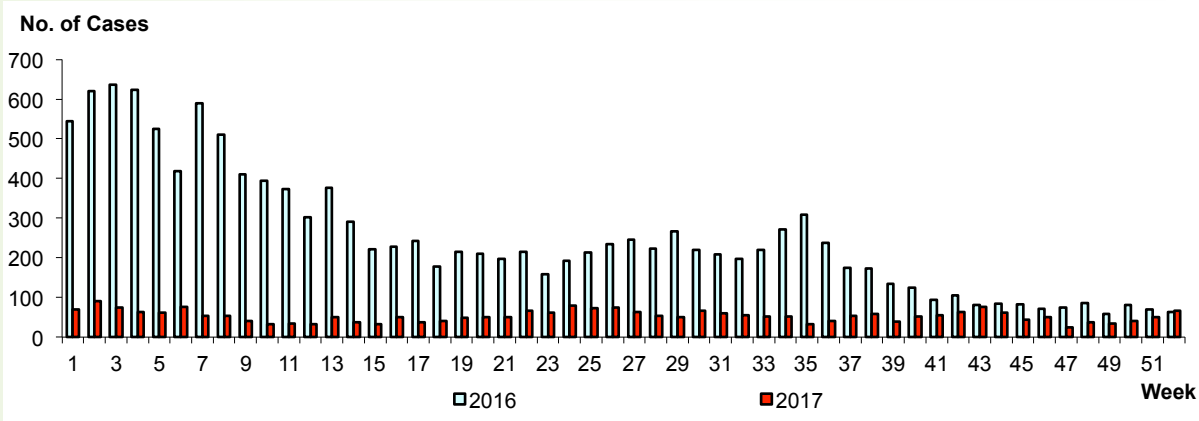


Table 3.5
Total number of notifications* received for DF/DHF cases, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	157	2	181	4	96	4	113	1	27	1
5-14	1,257	9	1,165	18	625	15	760	4	123	5
15-24	4,118	18	3,169	46	1,792	39	2,046	7	313	17
25-34	5,907	32	4,971	106	2,916	93	3,338	18	620	32
35-44	4,552	41	3,789	83	2,184	72	2,651	14	459	27
45-54	2,889	18	2,384	46	1,508	37	1,864	7	352	17
55-64	1,660	16	1,256	23	1,012	20	1,176	4	296	11
65+	1,323	7	897	13	723	11	900	2	328	11
Total	**21,863**	**143**	**17,812**	**339**	**10,856**	**291**	**12,848**	**57**	**2,518**	**121**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

The resident incidence rate among indigenous cases was highest in the 65+ 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^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	14	13	27	1.1	12.3
5-14	76	47	123	4.9	24.8
15-24	182	131	313	12.4	43.3
25-34	397	223	620	24.6	48.8
35-44	271	188	459	18.2	49.6
45-54	210	142	352	14.0	46.7
55-64	178	118	296	11.8	47.3
65+	158	170	328	13.0	59.0
Total	**1,486**	**1,032**	**2,518**	**100**	

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2017 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^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	659	565	1,224	48.6	41.5
Malay	143	88	231	9.2	43.5
Indian	104	63	167	6.6	46.5
Others	100	57	157	6.2	122.6
Foreigners	480	259	739	29.4	44.9
Total	**1,486**	**1,032**	**2,518**	**100**	**44.9**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

There were 249 (9.0%) imported cases, defined as Singaporeans, permanent and temporary residents, tourists and other foreigners with a history of travel to dengue endemic countries within seven days prior to the onset of illness. The majority of these cases (63.5%) were from Southeast Asian countries: 49 from Malaysia, 43 from Indonesia, 22 from Philippines, 17 from Myanmar, 11 from Thailand, 10 from Viet Nam, four from Cambodia, one each from East Timor and Laos, and the remaining were from other regions (Table 3.8).

Table 3.8
Imported DF/DHF cases, 2013-2017

	Year				
	2013	**2014**	**2015**	**2016**	**2017**
Southeast Asia					
Brunei	1	1	0	1	0
Cambodia	2	1	1	3	4
East Timor	1	5	0	0	1
Indonesia	116	143	116	99	43
Laos	0	1	0	0	1
Malaysia	90	214	191	33	49
Myanmar	9	8	9	2	17
Philippines	10	17	26	12	22
Thailand	21	27	21	10	11
Viet Nam	6	8	7	7	10
South Asia					
Bangladesh	4	6	6	5	6
China	12	9	2	0	1
India	17	39	35	10	61
Maldives	1	6	3	1	2
Nepal	0	1	0	0	0
Pakistan	1	0	1	0	1
Sri Lanka	1	6	2	2	11
Other Regions	15	22	18	10	9
Total	**307**	**514**	**438**	**195**	**249**

Residents from Housing and Development Board (HDB) flats, landed properties (including shop houses), condominiums constituted 75.6%, 10.9%, 12.9% of the cases, respectively. The incidence rate of residents from landed properties houses (78.2 per 100,000) was 1.8 times more than that of residents from HDB flats (42.6 per 100,000) (Table 3.9).

Table 3.9
Incidence rate of reported indigenous DF/DHF cases by housing type for Singapore residents, 2017

Housing Type	No.	%	Incidence rate per 100,000 population*
HDB Flats	1,334	75.6	42.6
Landed Properties (including shop houses)	195	10.9	78.2
Condominiums	229	12.9	43.6
Others	11	0.6	32.1
Total	**1,779**	**100**	**44.9**

*Rates are based on 2017 estimated mid-year of population.
(Source: Singapore Department of Statistics)

A total of 197 clusters involving 770 epidemiologically linked cases were identified in 2017, of which 11 clusters (5.6 %) had 10 or more cases (Table 3.10). Areas with more than 50 cases are listed in Table 3.10. The median number of cases was two and the median duration of transmission was 10 days (Table 3.11).

Table 3.10
Dengue clusters identified, 2013-2017

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)
2013	21,863	1,475	10,256 (46.9)	188 (12.7)	3	9
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	12,848	1,432	6,875 (53.5)	104 (7.3)	3	8
2017	2,518	197	770 (30.4)	11 (5.6)	2	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, 2017 (50 or more cases)

S/No.	Locality	No. of cases	Month
1	Bedok Reservoir Rd (Blk 713, 715, 716, 717, 718, 719, 721)	58	September
2	Hougang Ave 7 (Blk 354, 357) / Hougang Ave 7 (Rio Casa, The Florida) / Construction Site @ Upp S'goon View / Upp S'goon View / Upp S'goon View (Boathouse Residences, Heron Bay, Rio Vista)	109	December

Dengue deaths

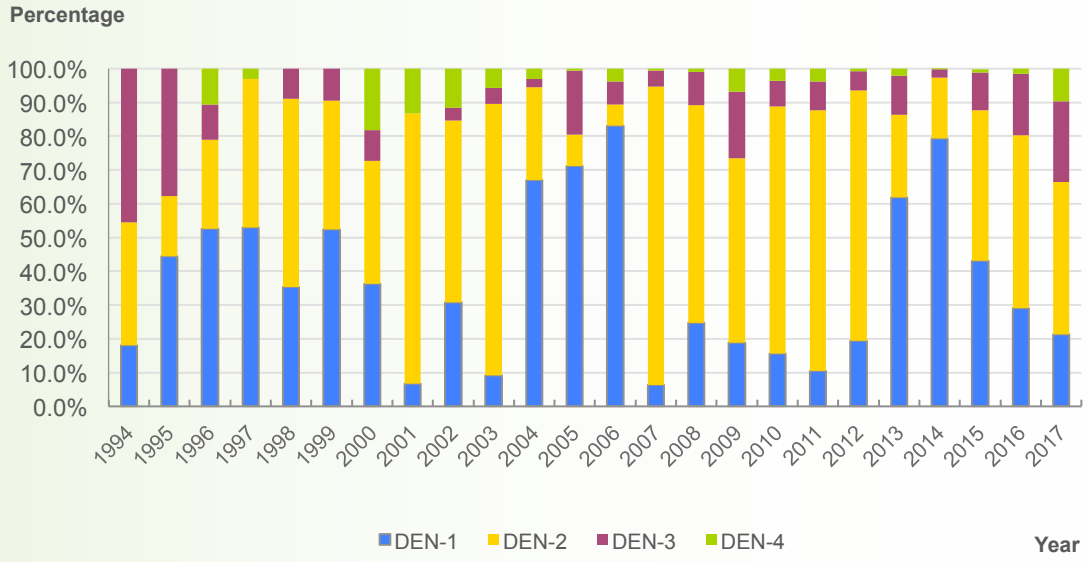
A total of two fatal cases were reported in 2017. Both were classified as imported cases. Both cases involved foreigners who sought medical treatment in Singapore. Their conditions subsequently deteriorated and they passed away in Singapore.

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 801 blood samples obtained from both inpatients and outpatients tested positive for dengue virus by PCR. DEN-1 was the predominant circulating serotype from 2013 to 2014 while DEN-2 was found to be the predominant circulating serotype in 2015 to 2017 (Figure 3.4).

Figure 3.4
Percentages of dengue virus serotypes, 1994-2017



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 outreach and social mobilisation, enforcement and research.

Surveillance is built on the current regime of inspecting premises and 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, and to communicate risk to the community. This is complemented by adult mosquito surveillance using Gravitraps, which capture gravid 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 systematic search and destroy of potential breeding habitats in outdoor areas helps to reduce the vector population to a low level before the onset of the peak season for dengue transmission, which typically falls between May and October.

To control the vector population in dengue/Zika 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 over the past seven years, 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 female *Aedes aegypti* 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 insects.

NEA has been conducting a small-scale field study, involving the release of male *Wolbachia-Aedes* mosquitoes at three selected sites in Singapore. The study will help us understand the horizontal and vertical flight ranges, longevity and competitiveness of *Wolbachia*-carrying *Aedes aegypti*. These data are required to support the design of a subsequent suppression trial, in which male *Wolbachia*-carrying *Aedes* mosquitoes will be released for further tests on their ability to reduce the mosquito population. As male mosquitoes do not bite, the release will not pose any additional risk of biting or disease transmission.

Situation in 2017

A total of 2,767 cases were reported in 2017. This was 78.9% lower than 2016. DEN-2 was the predominant virus serotype in 2017. Overall, 45.1% of the serotyped dengue cases were DEN-2, followed by DEN-1 (24.1%), DEN-3 (21.3%) and DEN-4 (9.5%).

In 2017, NEA inspected some 1.2 million premises and surveyed over 101,000 outdoor areas. These included residential premises, construction sites, schools and factories. 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. The overall *Aedes* House Index (HI) was 0.58%, 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 (25.1%), flower pot plates/trays (11.1%), ornamental containers (8.7%), discarded receptacles (4.7%) and closed perimeter drains (4.4%) (Figure 3.9). As for *Aedes albopictus*, the most common breeding habitats were domestic containers (10.0%), discarded receptacles (8.8%), flower pot plates (8.7%), closed perimeter drains (7.4%) and canvas sheets/plastic sheets (5.1%) (Figure 3.10).

Figure 3.5
Geographical distribution of dengue cases, 2017

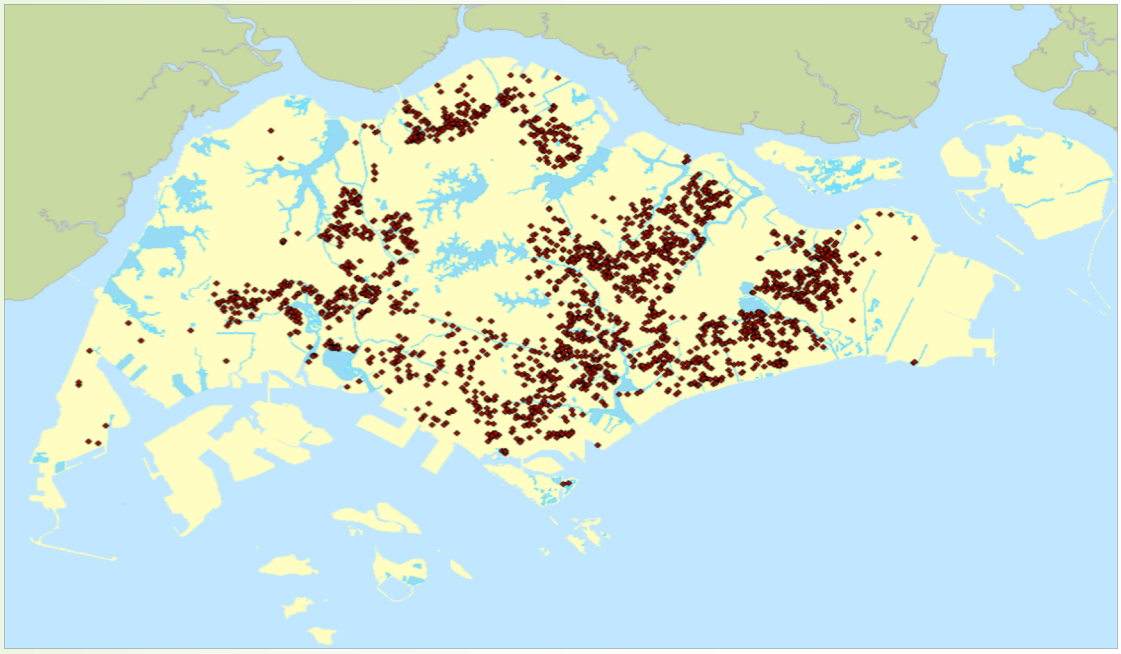


Figure 3.6
Geographical distribution of *Aedes aegypti* breeding habitats detected, 2017

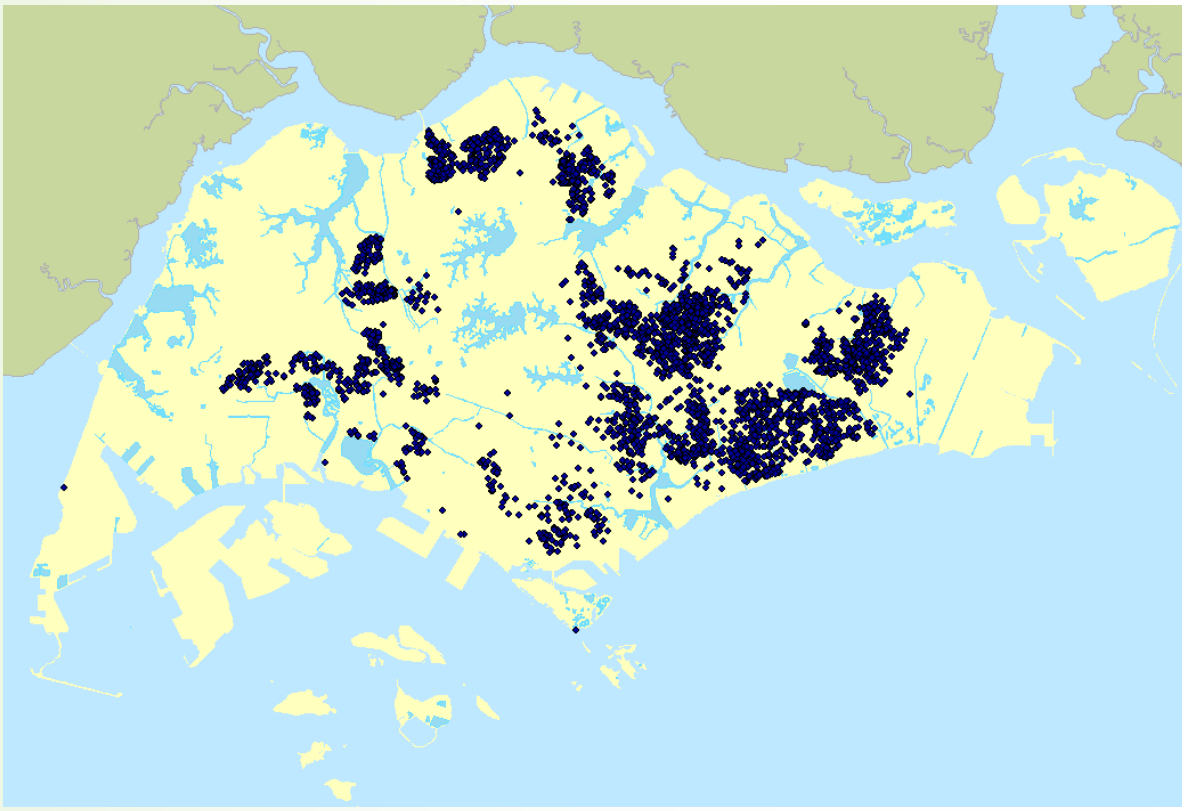


Figure 3.7
Geographical distribution of *Aedes albopictus* breeding habitats detected, 2017

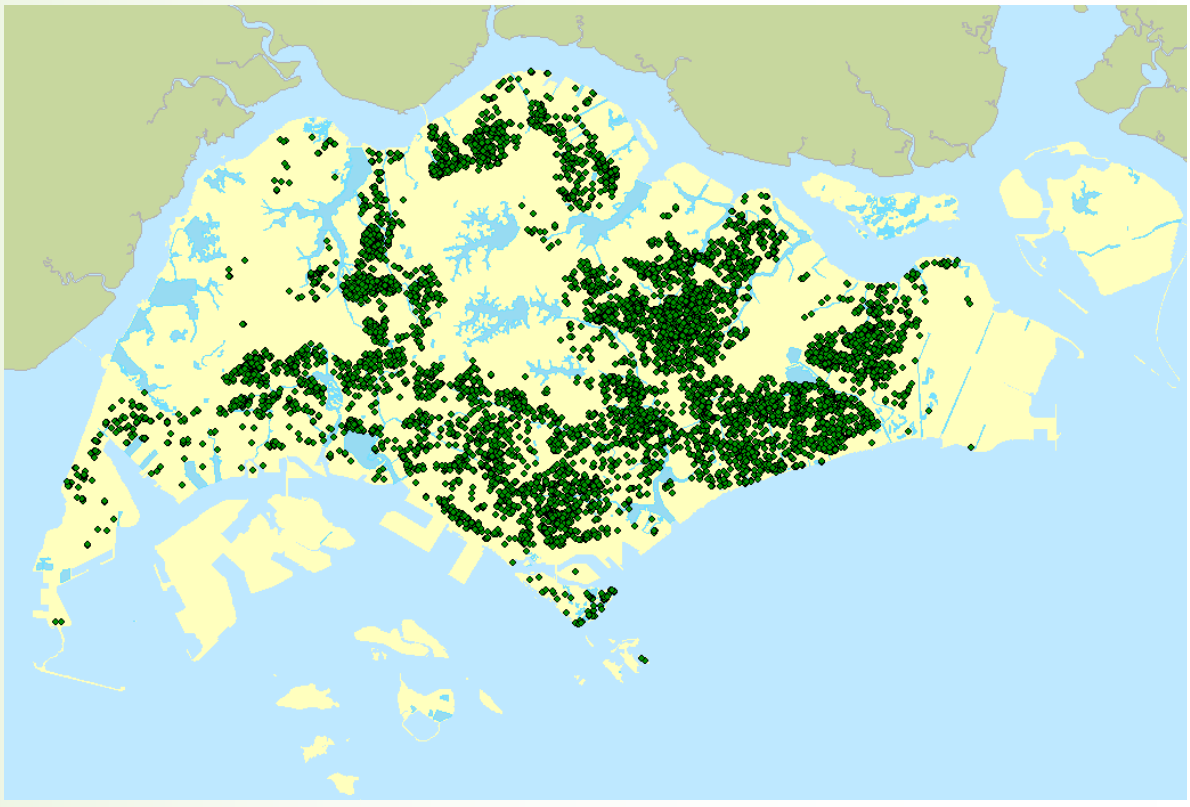


Figure 3.8
***Aedes* House Index, 2014-2017**

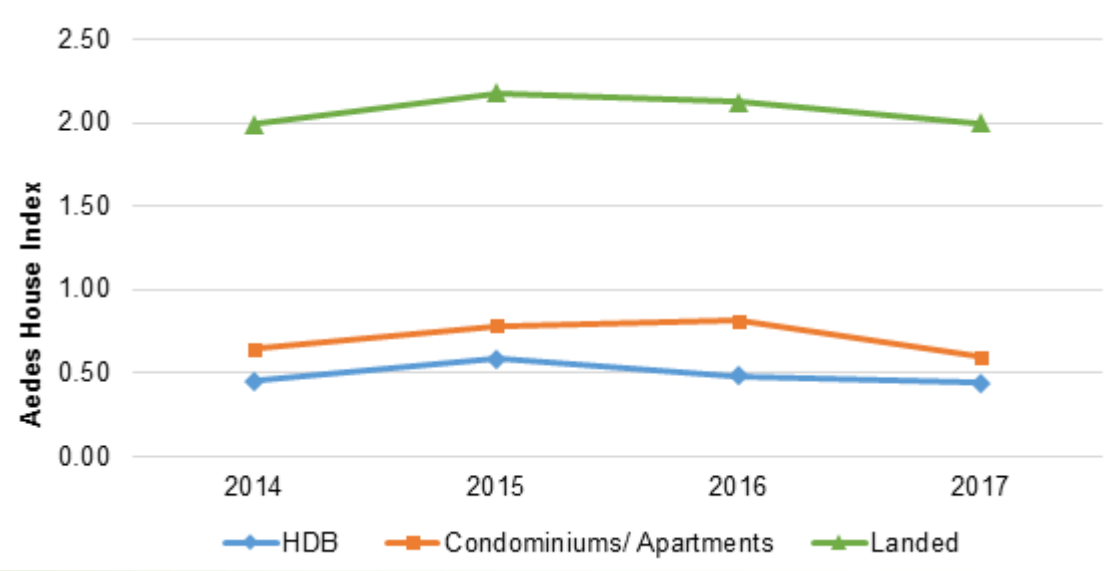


Figure 3.9
Distribution of *Aedes aegypti* top 5 breeding habitats, 2017

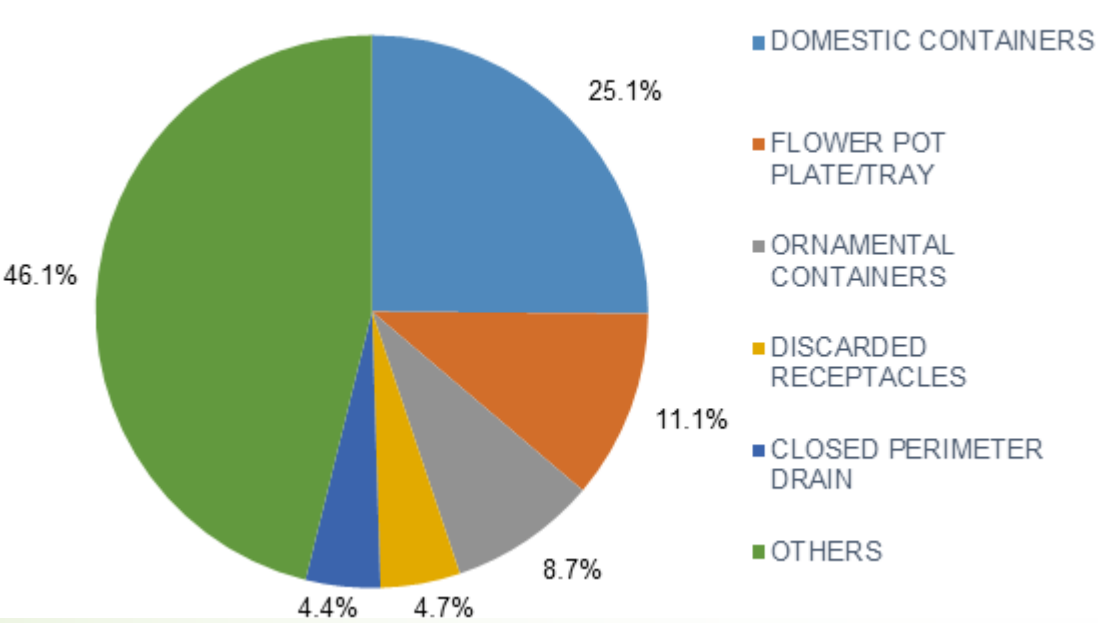
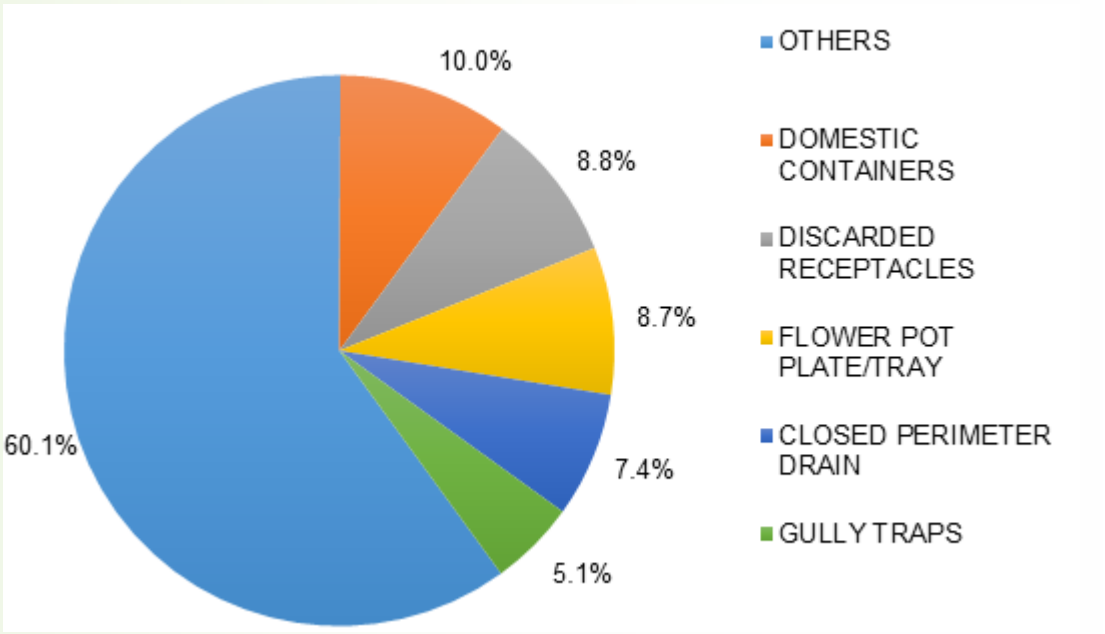


Figure 3.10
Distribution of *Aedes albopictus* top five breeding habitats, 2017



Of the 197 clusters notified in 2017, the two largest clusters were located at Upper Serangoon View and Bedok Reservoir Road area.

The largest cluster in 2017, involving 109 cases, was located at Hougang Ave 7 (Blk 354, 357) / Hougang Ave 7 (Rio Casa, The Florida) / Construction Site @ Upp S'goon View / Upp S'goon View / Upp S'goon View (Boathouse Residences, Heron Bay, Rio Vista)

Outbreak of Dengue fever at Hougang Ave 7 (Blk 354, 357) / Hougang Ave 7 (Rio Casa, The Florida) / Construction Site @ Upp S'goon View / Upp S'goon View / Upp S'goon View (Boathouse Residences, Heron Bay, Rio Vista)

On 17 December 2017, the Ministry of Health (MOH) was notified of a dengue case, residing and working at Upper Serangoon View. Another dengue case was notified on 18 December 2017. As soon as the cases were notified, epidemiological investigations and vector control operations were carried out. A total of 109 cases were identified from the outbreak. All the cases had symptoms onset between 12 December 2017 and 30 January 2018. 21 of the 109 (19.3%) cases who were screened had DEN-1. The epidemic curve is shown in Figure 3.11.

Majority of the cases were in the 15-55 age years group (92.7%). The female to male ratio was 1:3.7. Of the 109 cases, 17 were not working and involved one infant (0.9%), 12 students (11.0%), two housewives (1.8%) and two retirees (1.8%). A break-down of the remaining 92 cases with occupation showed that there were 60 construction workers (55.0%), four lecturers/ teachers, three engineers, three managers and 18 adults working in other occupations. Figure 3.12 shows the geographical distribution of cases in the cluster.

Figure 3.11
Time distribution of 109 dengue cases in the Hougang Ave 7 (Blk 354, 357) / Hougang Ave 7 (Rio Casa, The Florida) / Construction Site @ Upp S'goon View / Upp S'goon View / Upp S'goon View (Boathouse Residences, Heron Bay, Rio Vista) cluster area

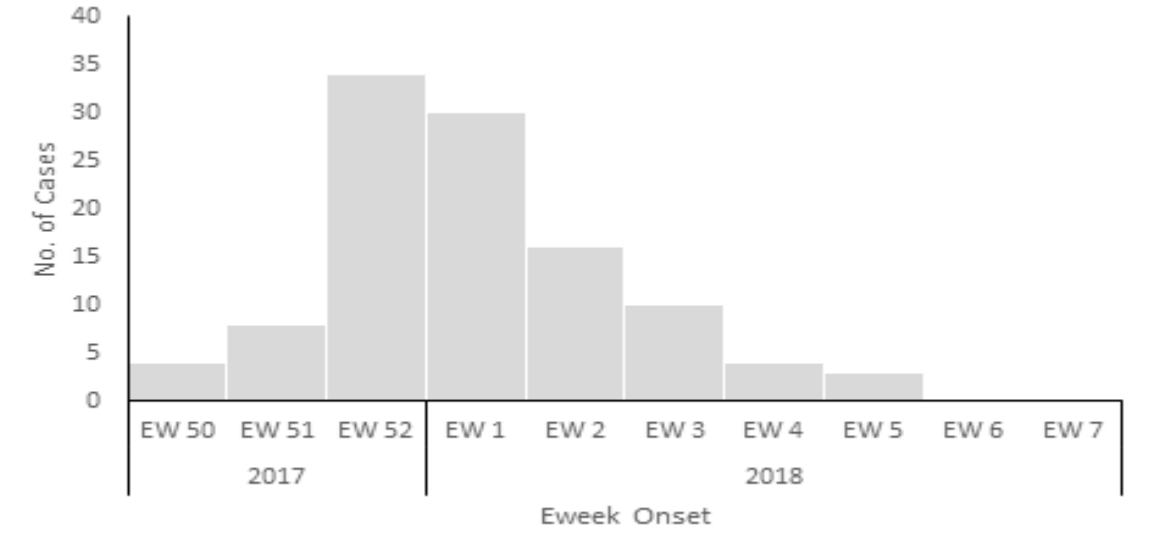


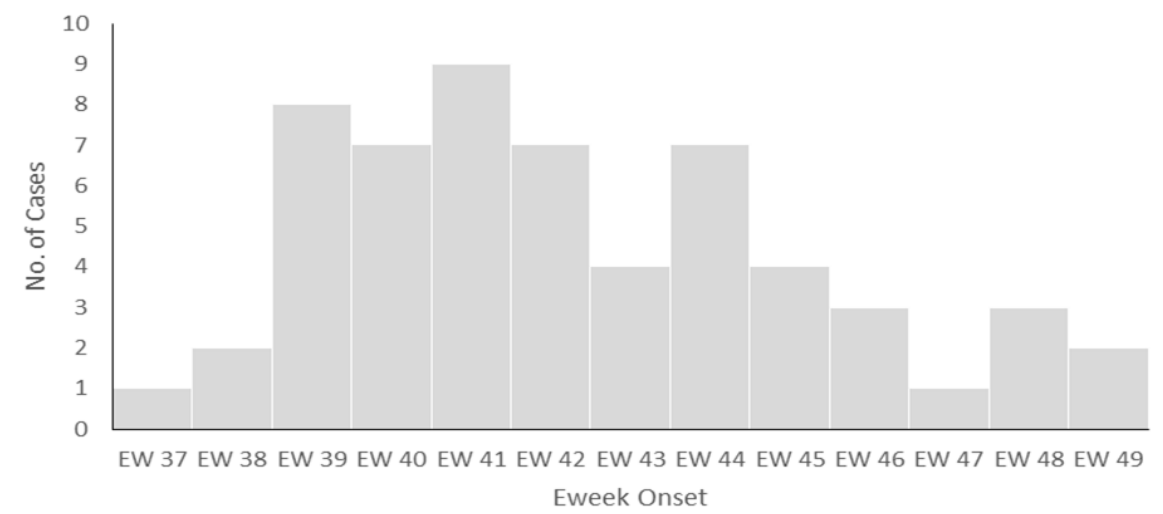
Figure 3.12
Geographical distribution of 109 dengue cases in the Hougang Ave 7 (Blk 354, 357) / Hougang Ave 7 (Rio Casa, The Florida) / Construction Site @ Upp S'goon View / Upp S'goon View / Upp S'goon View (Boathouse Residences, Heron Bay, Rio Vista) cluster

A total of 44 mosquito breeding habitats were detected and destroyed. The top three breeding habitats were flower pots/plates/stand, domestic containers (pails, plastic containers) and ornamental containers (glass bowls and porcelain container). 65.9% of the breeding habitats were detected in residential premises, 15.9% in outdoor areas, 13.6% at construction site and 4.6% in other type of premises. Overall, the breeding detected comprised 56.8% of *Aedes aegypti, 29.5%* of *Aedes albopictus*, 9.2% of mixed *Aedes aegypti* and *Aedes albopictus,* and 4.5% of *Culex quinquefasciatus*.

Outbreak of dengue fever at Bedok Reservoir Road (Blk 713, 715, 716, 717, 718, 719, 721)

On 15 September 2017, the MOH was notified of a dengue case residing at Block 719, Bedok Reservoir Road. Another case was reported on 25 September 2017 at Block 716, Bedok Reservoir Road. As soon as the cluster was notified, epidemiological investigations and vector control operations were carried out. A total of 58 cases were reported in the outbreak. The cases had symptoms onset between 11 September 2017 and 4 December 2017. 25 of the 58 cases who were screened had DEN-4. The epidemic curve is shown in Figure 3.13.

Figure 3.13
Time distribution of 58 dengue cases at Bedok Reservoir Rd
(Blk 713, 715, 716, 717, 718, 719, 721)



52 of the 58 cases (89.7%) were Singapore residents. Majority of the cases were in the 15-55 years age group (60.3%). The female to male ratio was 1:1.2. The 58 cases involving Singapore residents included six students, three housewives, eight retirees, 25 working adults and one unemployed person [Note that 15 (25.9%) cases were not tagged with occupation].

Figure 3.14 shows the geographical distribution of cases in the cluster.

Figure 3.14
Geographical distribution of 58 dengue cases at Bedok Reservoir Rd (Blk 713, 715, 716, 717, 718, 719, 721)

43 mosquito breeding habitats were detected and destroyed. The top two breeding sites were domestic containers (pails, containers) and harden soil found on flower pots. 60.5% of the breeding habitats were detected in residential premises, with the remaining in outdoor areas. *Aedes aegypti* accounted for 60.5% of the breeding. 39.5% were *Aedes albopictus*.

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.

A total of 53 laboratory confirmed cases of leptospirosis were reported, of which 29 were indigenous cases and 24 were imported cases. Of the 53 confirmed cases, 32 were Singapore residents, comprising 19 indigenous and 13 imported cases. The remaining 21 cases comprised of 15 foreigners who worked in Singapore and six foreigners who came to Singapore for medical treatment (imported) (Tables 3.12 and 3.13). Of the 15 foreigners who worked in Singapore, 10 were indigenous cases and five were imported cases. A total of three deaths were reported, of which two were classified as local cases and the remaining one as an imported case.

Table 3.12
Age-gender distribution and age-specific resident incidence rate of reported leptospirosis cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	3	1	4	8.5	1.0
15-24	11	6	17	36.2	2.8
25-34	8	2	10	21.3	0.9
35-44	4	2	6	12.8	0.3
45-54	6	2	8	17.0	0.8
55-64	1	0	1	2.1	0.2
65+	1	0	1	2.1	0.2
Total	**34**	**13**	**47**	**100**	

^Excluded six foreigner seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 3.13
Ethnic-gender distribution and ethnic-specific incidence rate of reported Leptospirosis cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	15	6	21	44.7	0.7
Malay	2	1	3	6.3	0.6
Indian	4	2	6	12.8	1.7
Others	0	2	2	4.3	1.6
Foreigners	13	2	15	31.9	0.9
Total	**34**	**13**	**47**	**100**	**0.8**

^Excluded six foreigner seeking medical treatment in Singapore.
*Rates are based on 2017 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 2017, a total of 39 laboratory confirmed cases were reported, an increase of 26% compared to the 31 cases reported in 2016 (Figure 3.15). All 39 cases were imported (Table 3.14).

Figure 3.15
Weekly distribution of reported malaria cases, 2016-2017

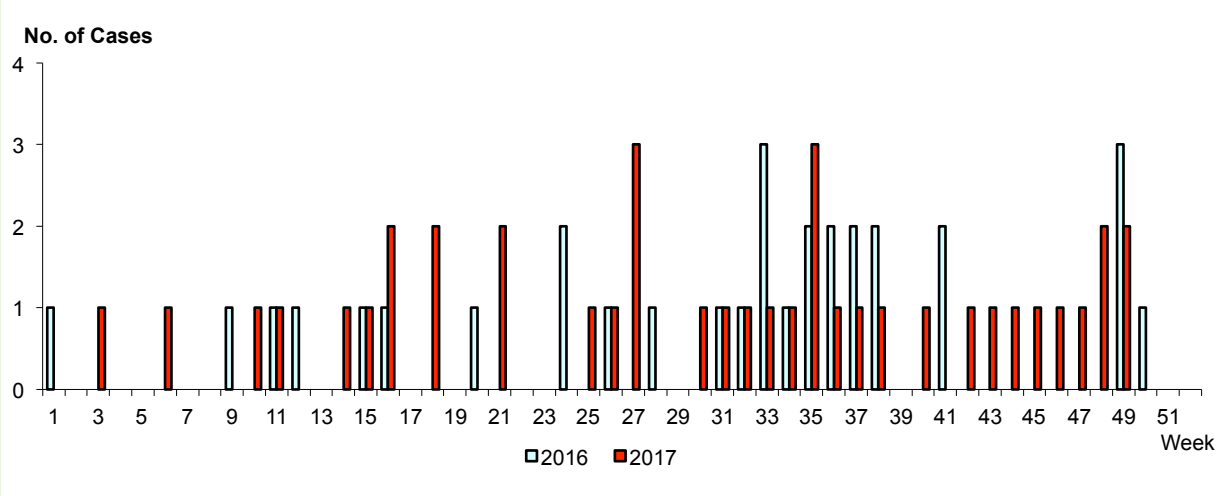


Table 3.14
Total number of notifications* received for malaria cases, 2013-2017

Age group	2013		2014		2015		2016		2017	
	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	1	0	0	0	0
15-24	1	27	0	8	0	8	0	6	0	2
25-34	0	39	0	25	0	13	0	11	0	10
35-44	0	12	0	9	0	4	0	1	0	7
45-54	0	3	0	5	0	1	0	2	0	2
55-64	0	5	0	3	0	3	0	1	0	1
65+	0	0	0	0	0	0	0	0	0	0
Total	**1**	**87**	**0**	**51**	**0**	**30**	0	**21**	**0**	**22**

*Excluded tourists and foreigners seeking medical treatment in Singapore

Among the imported cases, the resident incidence rate was highest in the 45-54 years age group, with an overall male to female ratio of 6:1 (Table 3.15). Foreigners had a higher incidence rate compared to Singapore residents. (Table 3.16).

Table 3.15
Age-gender distribution and age-specific resident incidence rate of reported malaria cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	1	1	2	9.1	0
25-34	9	1	10	45.5	0.2
35-44	6	1	7	31.8	0.2
45-54	2	0	2	9.1	0.3
55-64	1	0	1	4.5	0.2
65+	0	0	0	0	0
Total	**19**	**3**	**22**	**100**	

^Excluded 17 tourists and foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 3.16
Ethnic-gender distribution and ethnic-specific incidence rate of reported malaria cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	1	0	1	4.6	0
Malay	0	0	0	0	0
Indian	3	0	3	13.6	0.8
Others	1	0	1	4.5	0.8
Foreigners	14	3	17	77.3	1.0
Total	**19**	**3**	**22**	**100**	**0.4**

^ Excluded 17 tourists and foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Malaria parasite species

The distribution of the cases by parasite species was *P. vivax* (46.2%), *P. falciparum* (46.2%), *P. knowlesi* (5.0%) and *P. ovale* (2.6%) (Table 3.17).

Table 3.17
Classification of reported malaria cases by parasite species, 2017

Classification	Parasite species					Total (%)
	P.v.	P.f.	P.o.	P.m.	P.k.	
Imported**	18	18	1	0	2	39 (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	**18**	**18**	**1**	**0**	**2**	**39 (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 (43.6%) and Africa (41.0%). *P. vivax* accounted for 94.1% of the infections acquired in India, and *P. falciparum* accounted for 93.8% of the infections acquired in the African region (Table 3.18).

Table 3.18
Imported malaria cases by country/ region of origin and by parasite species, 2017

	Parasite species					
	P.v.	**P.f.**	**P.o.**	**P.m.**	**P.k.**	**Total (%)**
Southeast Asia						
Indonesia	1	1	0	0	0	2 (5.0)
Malaysia	0	0	0	0	1	1 (2.6)
Philippines	0	0	0	0	1	1 (2.6)
South Asia						
Pakistan	1	0	0	0	0	1 (2.6)
India	16	1	0	0	0	17 (43.6)
Africa						
Angola	0	1	0	0	0	1 (2.6)
Cameroon	0	1	0	0	0	1 (2.6)
Chad	0	1	0	0	0	1 (2.6)
Congo	0	1	0	0	0	1 (2.6)
Equatorial Guinea	0	1	0	0	0	1 (2.6)
Ghana	0	2	0	0	0	2 (5.0)
Ivory Coast	0	1	0	0	0	1 (2.6)
Kenya	0	2	0	0	0	2 (5.0)
Nigeria	0	4	1	0	0	5 (12.8)
Tanzania	0	1	0	0	0	1 (2.6)
Other countries						
Papua New Guinea	0	1	0	0	0	1 (2.6)
Total	**18**	**18**	**1**	**0**	**2**	**39 (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 (74.3%) had onset of fever within three weeks of entry into Singapore (Table 3.19). For *P. vivax* malaria, 50% of cases did not develop symptoms until more than six weeks after entry, while for *P. falciparum,* 94% of cases developed symptoms less than two weeks into Singapore.

Table 3.19
Imported malaria cases by interval between period of entry and onset of illness[#] and by parasite species, 2017

Interval in weeks	Parasite species					
	P.v.	P.f.	P.o.	P.m.	P.k.	Total (%)
<2	9	17	1	0	2	29 (76.3)
2-3	0	0	0	0	0	0
4-5	0	0	0	0	0	0
6-7	0	0	0	0	0	0
8-9	0	0	0	0	0	0
10-11	0	0	0	0	0	0
12-13	0	0	0	0	0	0
14-15	0	0	0	0	0	0
16-17	1	0	0	0	0	1 (2.6)
18-19	0	0	0	0	0	0
20-23	0	0	0	0	0	0
24-27	2	0	0	0	0	2 (5.3)
28-31	2	0	0	0	0	2(5.3)
32-35	0	0	0	0	0	0
36-39	1	0	0	0	0	1 (2.6)
40+	3	0	0	0	0	3 (7.9)
Total	**18**	**17**	**1**	**0**	**2**	**38 (100)**

[#] One asymptomatic *P. falciparium* 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 39 imported cases comprised five Singapore residents (12.8%), 14 work permit/employment pass holders (35.9%), two student pass holders (5.1%), one foreigner residing in Singapore (2.6%), nine foreigners seeking medical treatment in Singapore (23.12%) and eight tourists (20.5%) (Table 3.20).

Table 3.20
Classification of imported malaria cases, 2016-2017

Classification	2016		2017	
	Cases	%	Cases	%
Local residents				
Singapore residents	1	3.2	5	12.8
Work permit/Employment pass holders	15	48.4	14	35.9
Student pass holders	3	9.7	2	5.1
Other foreigners	2	6.5	1	2.6
Foreigners seeking medical treatment	4	12.9	9	23.1
Tourists	6	19.3	8	20.5
Total	31	100	39	100

Out of five Singapore residents who contracted malaria overseas, one contracted malaria whilst on a business trip, while the rest were overseas for social visits or holiday. All were not known to have taken chemoprophylaxis (Tables 3.21 and 3.22).

Table 3.21
Purpose of travel for Singapore residents who contracted malaria overseas, 2013-2017

Purpose of Travel	2013	2014	2015	2016	2017
Social visits/holidays	10	5	5	0	4
Business	3	4	0	1	1
Military service	0	0	0	0	0
Volunteer/Missionary work	2	1	1	0	0
Employment	1	0	1	0	0
Total	**16**	**10**	**7**	**1**	**5**

Table 3.22
History of chemoprophylaxis for Singapore residents who contracted malaria overseas, 2013-2017

Chemoprophylaxis	2013	2014	2015	2016	2017
Took complete chemoprophylaxis	0	0	0	0	0
No chemoprophylaxis	16	10	7	1	5
Irregular/incomplete chemoprophylaxis	0	0	0	0	0
Total	**16**	**10**	**7**	**1**	**5**

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, myagia, 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.

Since 1 January 2017, a total of 12 cases of murine typhus were reported. Of these cases, one was a confirmed case while the remaining were suspect cases. The confirmed case was an indigenous case involving a local resident (Tables 3.23 and 3.24).

The 11 suspect cases comprised 10 indigenous cases and one imported case. Eight (72.8%) involved Singapore residents and three (27.2%) were foreigners working in Singapore. The majority of cases were female, and the resident incidence rate was highest for the 5-14 years age group, with an overall male to female ratio of 1:1.75 (Tables 3.25 and 3.26).

Table 3.23
Age-gender distribution and age-specific resident incidence rate of reported confirmed murine typhus cases, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
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	100	0.2
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**	

* Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 3.24
Ethnic-gender distribution and ethnic-specific incidence rate of reported confirmed murine typhus cases, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	1	0	1	100	0
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**

* Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 3.25
Age-gender distribution and resident age-specific incidence rate of reported suspect murine typhus cases, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	0	3	3	27.3	0.7
15-24	0	1	1	9.1	0.4
25-34	3	2	5	45.4	0.2
35-44	1	0	1	9.1	0.2
45-54	0	1	1	9.1	0
55-64	0	0	0	0	0
65+	0	0	0	0	0
Total	**4**	**7**	**11**	**100**	

* Rates are based on 2017 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, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	1	1	2	18.2	0.1
Malay	0	4	4	36.4	0.8
Indian	0	2	2	18.2	0.6
Others	0	0	0	0	0
Foreigners	3	0	3	27.2	0.2
Total	**4**	**7**	**11**	**100**	**0.2**

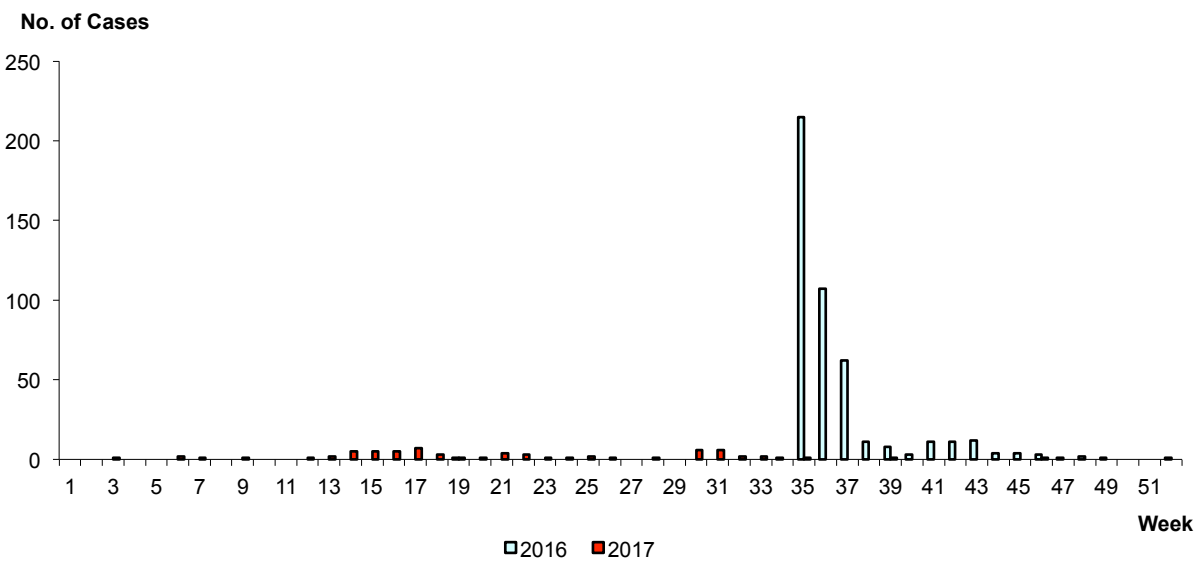
* Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

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.

A total of 67 laboratory confirmed cases of Zika virus infection were reported in 2017, compared to 458 laboratory confirmed cases in 2016 (Figure 3.16). Out of the 67 cases, three were imported cases, involving Singapore residents. The remaining 64 cases were indigenous cases.

Figure 3.16
Weekly distribution of reported Zika cases, 2016-2017



The resident incidence rate among indigenous cases was highest in the 25-54 years age group with an overall male to female ratio of 1:1 (Table 3.27). Among the three major ethnic groups, Chinese had the highest incidence (Table 3.28).

Table 3.27
Age-gender distribution and age-specific resident incidence rate of indigenous Zika cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	0	1	1	1.6	0.2
15-24	2	2	4	6.2	0.4
25-34	12	3	15	23.4	2.1
35-44	7	10	17	26.6	2.1
45-54	6	7	13	20.3	2.1
55-64	4	5	9	14.1	1.6
65+	2	3	5	7.8	1.0
Total	**33**	**31**	**64**	**100**	

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 3.28
Ethnic-gender distribution and ethnic-specific incidence rate of indigenous Zika cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	28	25	53	82.8	1.8
Malay	0	2	2	3.1	0.4
Indian	0	0	0	0	0
Others	2	0	2	3.1	1.6
Foreigners	3	4	7	11.0	0.4
Total	**33**	**31**	**64**	**100**	**1.1**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

There were a total of 10 Zika clusters notified in 2017 (Table 3.29). The two largest clusters were at Highland Rd / Jansen Cl / Jln Sahabat / Kovan Rd / Upp S'goon Rd and S'goon Nth Ave 1. Both clusters had six cases each. The rest of the cases were sporadic cases that did not form a cluster.

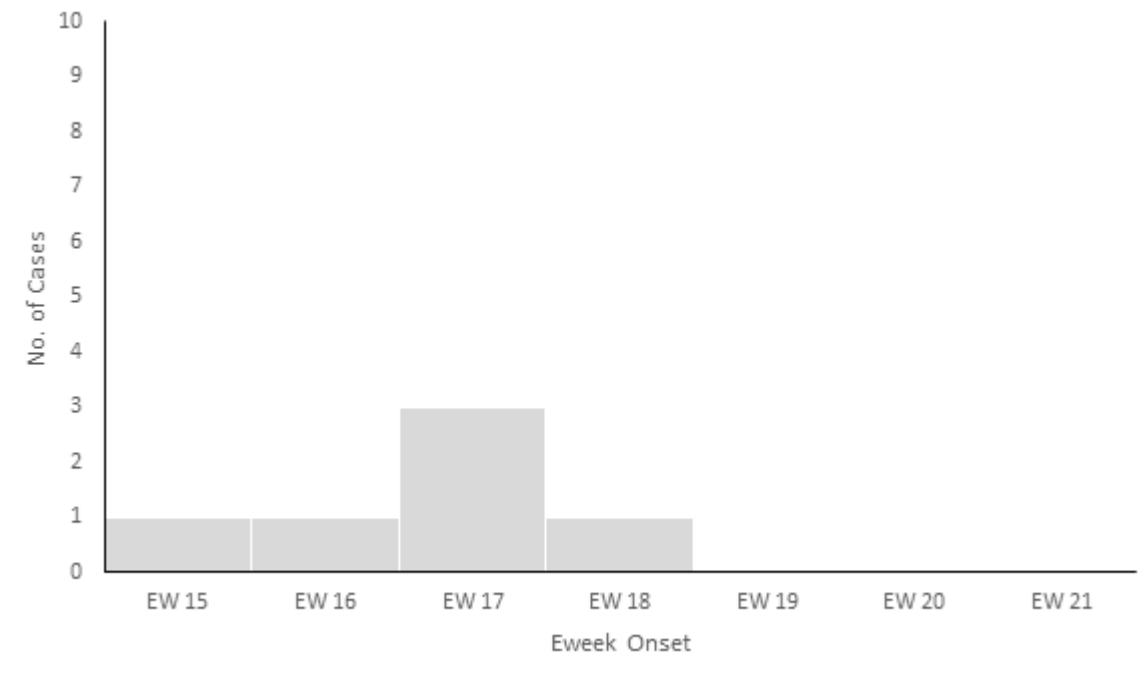
Table 3.29
Zika virus infection clusters identified, 2017

S/No.	Locality	No. of cases	Transmission Start Date	Transmission End Date	Transmission Period
1	Highland Rd / Jansen Cl / Jln Sahabat / Kovan Rd / Upp S'goon Rd (D'Pavilion)	6	13/4/2017	6/5/2017	26
2	S'goon Nth Ave 1 (Blk 103, 109, 115, 116, 117)	6	24/7/2017	13/8/2017	24
3	Poh Huat Rd West (Nouvelle Pk, The Waterline) / Poh Huat Ter / Terrasse Ln (Terrasse)	4	31/3/2017	20/4/2017	24
4	S'goon Nth Ave 1 (Blk 125, 126, 127)	4	16/7/2017	19/7/2017	8
5	Glasgow Rd	3	6/4/2017	20/4/2017	15
6	Kensington Pk Dr (Kensington Pk Condo)	3	8/6/2017	15/6/2017	9
7	Simon Pl	2	21/3/2017	21/3/2017	8
8	Flower Rd / Hendry Cl	2	30/3/2017	2/4/2017	11
9	Parry Ave	2	20/5/2017	28/5/2017	3
10	S'goon Nth Ave 1 (Blk 143) / S'goon Nth Ave 1 (S'goon Ville)	2	6/8/2017	8/8/2017	9

Outbreak at Highland Rd / Jansen Cl / Jln Sahabat / Kovan Rd / Upp S'goon Rd (D'Pavilion)

On 17 April 2017, the Ministry of Health (MOH) was notified of a locally transmitted Zika case residing at Jansen Close. Within a week, another case was reported in the vicinity. Epidemiological investigations and vector control operations were carried out upon the notification of the cases. A total of six cases were reported in the outbreak. The cases had symptoms onset dates between 13 April 2017 and 6 May 2017. The epidemic curve of the cluster is shown in Figure 3.17.

Figure 3.17
Time distribution of six Zika cases in the Highland Rd / Jansen Cl / Jln Sahabat / Kovan Rd / Upp S'goon Rd outbreak area



All six cases were Singapore residents. Majority of the cases (66.6%) were above 50 years of age. The female to male ratio was 1:2. Of the six cases, there were two retirees, one housewife and three working adults.

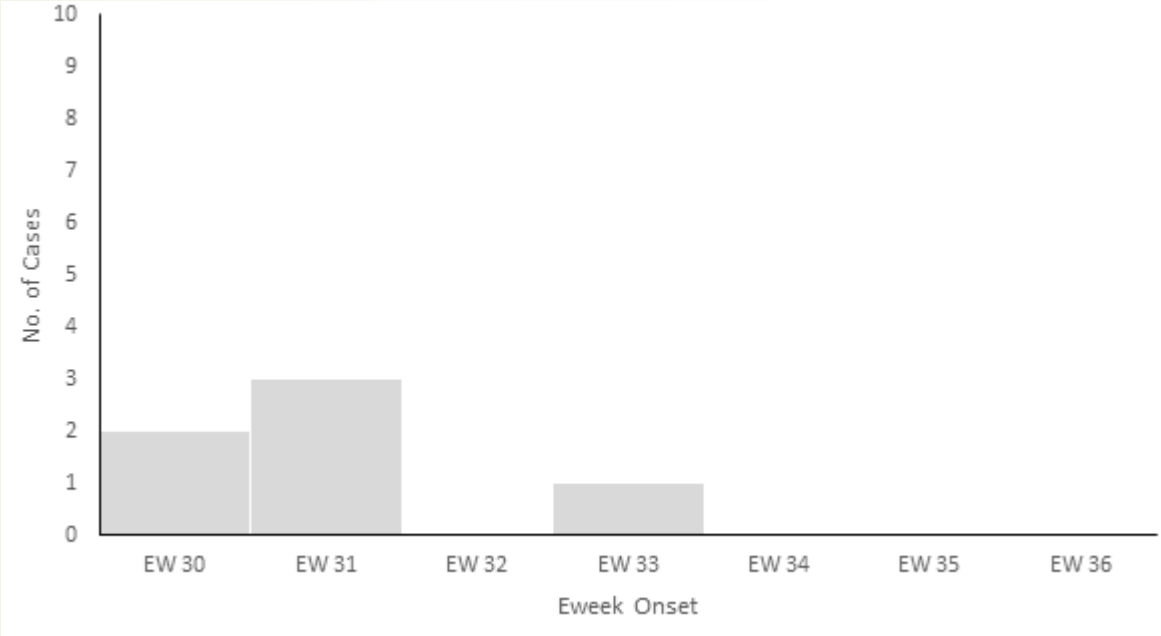
A total of seven mosquito breeding habitats were detected and destroyed. The top two breeding habitats detected were domestic containers and ground depressions. All the breeding habitats were detected within residential premises.

Overall, the breeding detected comprised 42.8% of *Aedes aegypti*, 25.6% of *Aedes albopitcus*, 14.3% of mixed breeding consisting of *Aedes aegypti* and *Aedes albopitcus* and 14.3% of *Culex quinquefasciatus*.

Outbreak at S'goon Nth Ave 1 (Blk 103, 109, 115, 116, 117)

On 31 July 2017, the Ministry of Health (MOH) was notified of a locally transmitted Zika case residing at Blk 109 S'goon Nth Ave 1. Within three days, another three cases were reported. Epidemiological investigations and vector control operations were carried out upon the notification of the cases. A total of six cases were reported in the outbreak. All the cases had symptoms onset dates between 24 July 2017 and 13 August 2017. The epidemic curve of the cluster is shown in Figure 3.18.

Figure 3.18
Time distribution of six Zika cases in the S'goon Nth Ave 1 outbreak area



Majority of the cases (83.3%) were in the 15-65 years age group. The female to male ratio was 1:1. Of the six cases, there were three working adults and the occupation of remaining three cases were not available.

A total of 13 mosquito breeding habitats were detected and destroyed. The top two breeding habitats were domestic containers and toilet bowl cisterns. 84.6% of the breeding habitats were found in residential premises and 15.4% of the breeding habitats were found in outdoor areas.

Overall, the breeding comprised 76.9% of *Aedes aegypti*, 15.4% of *Aedes albopitcus* and 7.7% of *Culex quinquefasciatus*.

CHAPTER 4

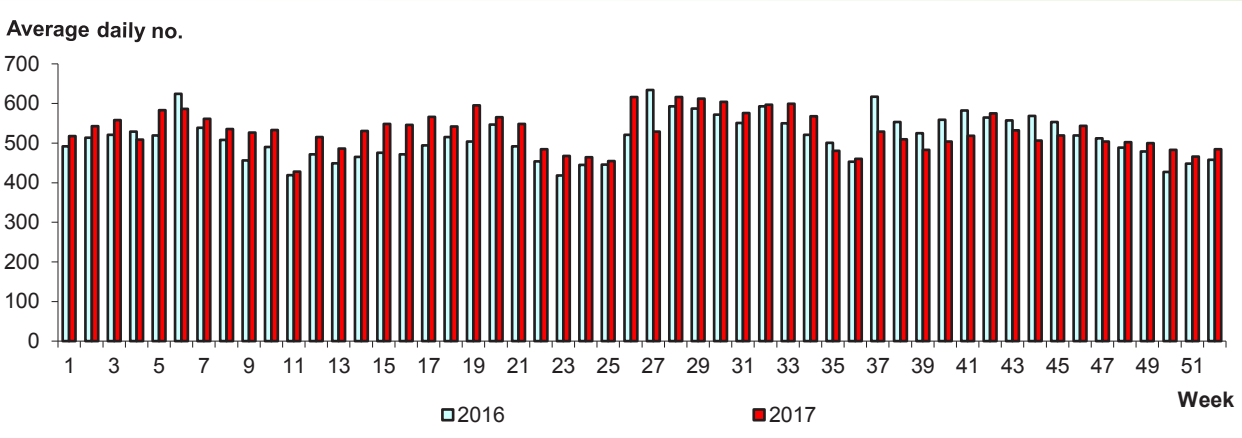
FOOD-BORNE DISEASES

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 146,092 attendances at polyclinics for acute diarrhoeal illness in 2017, an increase of 2.9% compared to the 142,004 seen in 2016. 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, 2016-2017



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 495 cases of *Campylobacter* enteritis were reported in 2017, an increase of 12.0% compared to 442 cases reported in 2016. *Campylobacter jejuni* was isolated in the majority of the cases (Table 4.1). Of the 495 reported cases, 34 were imported cases and 441 indigenous cases (Table 4.2). The remaining 20 cases comprised 11 tourists and nine 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 1.2:1 (Table 4.3). Among the three major ethnic groups, Indians had the highest incidence rate followed by Malays (Table 4.4).

Table 4.1
Incidence rate of reported *Campylobacter* enteritis cases^, 2013-2017

Year	No. of cases caused by					Incidence rate per 100,000 population*
	C. jejuni	*C. coli*	*C. laridis*	Other species	Total	
2013	335	14	0	48	397	7.4
2014	370	18	0	45	435	8.0
2015	334	31	0	55	420	7.6
2016	364	33	0	45	442	7.6
2017	364	39	0	72	475	8.5

Excluded tourists and foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics).

Table 4.2
Total number of notifications* received for *Campylobacter* enteritis, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	166	13	154	9	168	6	149	1	149	4
5-14	75	8	90	11	88	6	100	5	101	12
15-24	14	1	7	21	21	6	20	5	30	2
25-34	15	6	2	23	23	3	28	1	24	5
35-44	9	0	6	10	10	1	6	3	20	6
45-54	10	1	4	15	15	0	21	1	25	4
55+	68	6	1	63	63	4	82	2	92	1
Total	**357**	**35**	**370**	**40**	**388**	**26**	**406**	**18**	**441**	**34**

*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^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	83	70	153	32.2	64.5
5-14	74	39	113	23.8	21.4
15-24	19	13	32	6.7	5.5
25-34	15	14	29	6.1	3.5
35-44	15	11	26	5.5	3.4
45-54	14	15	29	6.1	3.4
55+	55	38	93	19.6	5.3
Total	**275**	**200**	**475**	**100**	

^Excluded 11 tourists and nine foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 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^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	166	96	262	55.2	8.9
Malay	24	29	53	11.2	10.0
Indian	19	20	39	8.2	10.9
Others	15	16	31	6.5	24.2
Foreigners	51	39	90	18.9	5.5
Total	**275**	**200**	**475**	**100**	**8.5**

^Excluded 11 tourists and nine foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 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 2017, three imported cases of cholera involving one tourist and two work permit holders were reported (Figure 4.2). The overall resident incidence rate was zero per 100,000 population (Tables 4.5 and 4.6).

Figure 4.2
Weekly distribution of reported cholera cases, 2016-2017

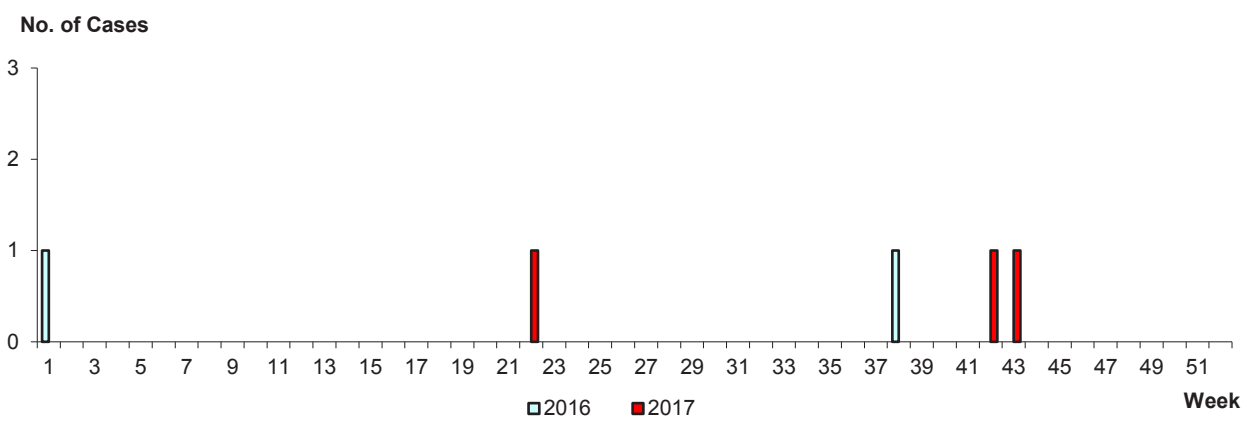


Table 4.5
Age-gender distribution and age-specific resident incidence rate of reported cholera cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	0	0	0	0	0
25-34	2	0	2	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	**2**	**0**	**2**	**100**	

^Excluded one tourist.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 4.6
Ethnic-gender distribution and ethnic-specific incidence rate of reported cholera cases^, 2017

	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	2	0	2	100	0.1
Total	**2**	**0**	**2**	**100**	**0**

^Excluded one tourist.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 4.7
Total number of notifications* received for reported cholera cases, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	1	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	0	0	1	0	0	0	0	0	2
35-44	0	2	0	0	0	2	0	0	0	0
45-54	0	0	0	0	0	0	0	0	0	0
55-64	0	0	0	0	1	0	0	0	0	0
65+	0	0	0	0	0	0	0	0	0	0
Total	**0**	**2**	**0**	**2**	**1**	**2**	**0**	**0**	**0**	**2**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

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 2013 to 2017, a total of 411 cases of enteric fever were reported, of which 307 (74.7%) cases were typhoid and 104 (25.3%) cases were paratyphoid. The majority (89.5%) were imported cases (Table 4.8).

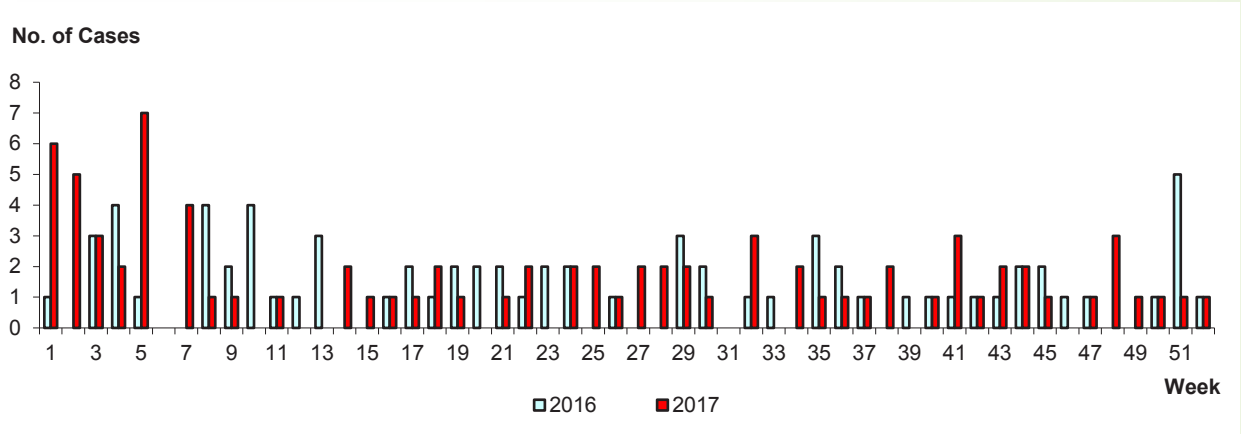
Table 4.8
Classification of reported enteric fever cases, 2013-2017

Year	Typhoid	Paratyphoid		Total
		A	B	
2013	84 (75)	23 (23)	0 (0)	107 (98)
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)
Total	**307 (272)**	**101 (96)**	**3 (0)**	**411 (368)**

( ) imported cases

In 2017, there were a total of 81 cases of enteric fevers comprising 65 cases of typhoid and 16 cases of paratyphoid A, an increase of 15.7% compared to 70 cases reported in 2016 (Figure 4.3).

Figure 4.3
Weekly distribution of reported enteric fever cases, 2016-2017



Typhoid

There were 65 reported cases of typhoid in 2017. 19 cases were Singapore residents, four were foreigners seeking medical treatment in Singapore and four were tourists. The remaining 38 cases comprised 29 foreigners working in Singapore, three dependent pass holders and six student pass holders (Table 4.9). During the period 2013 to 2017, majority of the cases of typhoid were imported and in the 25-34 years age group (Table 4.10). The resident incidence rate of typhoid was 0.5 per 100,000 population, with the highest incidence observed in the 5-14 years age group in 2017 (Table 4.11).

Table 4.9
Classification of reported typhoid and paratyphoid cases, 2017

Population Group	Typhoid No. (%)	Paratyphoid No. (%)
Singapore residents	19 (29.2)	7 (43.8)
Foreigners seeking medical treatment in Singapore	4 (6.2)	4 (25.0)
Tourists	4 (6.2)	0
Other categories of foreigners	38 (58.4)	5 (31.2)
Total	**65 (100)**	**16 (100)**

Table 4.10
Total number of notifications* received for reported typhoid cases, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	5	0	7	1	1	0	2	1	1
5-14	0	10	0	11	0	3	0	5	0	15
15-24	0	10	0	9	1	9	1	5	0	6
25-34	1	22	1	27	1	17	2	15	0	23
35-44	0	10	1	15	1	8	1	10	2	4
45-54	0	1	0	2	0	0	1	1	0	3
55-64	0	0	0	3	0	1	0	0	0	1
65+	1	1	0	3	0	0	1	1	0	1
Total	2	59	2	77	4	39	6	39	3	54

*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^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	1	1	2	3.1	0.5
5-14	7	8	15	26.3	2.0
15-24	3	3	6	9.2	0.2
25-34	19	4	23	35.4	0.4
35-44	4	2	6	10.5	0.5
45-54	2	1	3	5.2	0.3
55-64	1	0	1	1.5	0.2
65+	1	0	1	1.5	0.2
Total	**38**	**19**	**57**	**100**	

^ Excluded four foreigners seeking medical treatment in Singapore and four tourists.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Among the three major ethnic groups, Indians had the highest incidence rate (Table 4.12).

Table 4.12
Ethnic-gender distribution and ethnic-specific incidence rate of reported typhoid cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	4	2	6	10.5	0.2
Malay	0	0	0	0	0
Indian	5	7	12	21.0	3.3
Others	1	0	1	1.8	0.8
Foreigners	28	10	38	66.7	2.3
Total	**38**	**19**	**57**	**100**	**1.0**

^ Excluded four foreigners seeking medical treatment in Singapore and four tourists.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

The majority of the cases acquired the infection from South Asia (68.5%) and Southeast Asia (29.6%) (Table 4.13). Most Singapore residents acquired the disease while overseas on vacation (85.7%) (Table 4.14).

Table 4.13
Imported typhoid cases by country/ region of origin, 2016-2017

	2016	2017
	No. (%)	No. (%)
Southeast Asia		
Indonesia	6 (15.4)	5 (9.3)
Malaysia	3 (7.7)	2 (3.7)
Myanmar	8 (20.5)	9 (16.7)
Philippines	1 (2.6)	0
South Asia		
Bangladesh	9 (23.1)	17 (31.5)
India	12 (30.8)	20 (37.0)
Others		
Taiwan	0	1 (1.8)
Total	**39 (100)**	**54 (100)**

Table 4.14
Singapore residents who contracted typhoid overseas, 2013-2017

Purpose of travel	2013		2014		2015		2016		2017	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Vacation	23	95.8	14	77.8	13	92.9	12	85.7	16	88.9
Business/employment	1	4.2	2	11.1	1	7.1	2	14.3	0	0
Others	0	0	2	11.1	0	0	0	0	2	11.1
Total	**24**	**100**	**18**	**100**	**14**	**100**	**14**	**14**	**18**	**100**

Paratyphoid

Of the 16 reported cases of paratyphoid, seven were Singapore residents, four were foreigners seeking medical treatment in Singapore, three were foreigners working in Singapore, and two were dependent pass holders (Table 4.9). During the period 2013 to 2017, majority of the cases of paratyphoid were imported and in the 15-24 years age group (Table 4.15).

Table 4.15
Total number of notifications* received for reported paratyphoid cases, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	0	0	1	0	1	0	0
5-14	0	3	0	1	0	2	0	2	0	2
15-24	0	2	0	5	0	3	0	2	0	3
25-34	0	6	1	7	1	7	1	7	0	2
35-44	0	2	0	0	0	4	0	4	0	2
45-54	0	3	0	1	0	3	0	0	1	1
55-64	0	1	0	1	0	1	0	0	0	1
65+	0	0	1	0	2	0	1	0	0	0
Total	**0**	**17**	**2**	**15**	**3**	**21**	**2**	**16**	**1**	**11**

*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^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	1	1	2	16.7	0.2
15-24	2	1	3	25.0	0.2
25-34	1	1	2	16.7	0.2
35-44	0	2	2	16.7	0.2
45-54	0	2	2	16.7	0.2
55-64	0	1	1	8.3	0
65+	0	0	0	0	0
Total	**4**	**8**	**12**	**100**	

^ Excluded four foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Among the three major ethnic groups, Indians had the highest incidence rate (Table 4.17).

Table 4.17
Ethnic-gender distribution and ethnic-specific incidence rate of reported paratyphoid cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	0	2	2	16.7	0.1
Malay	0	0	0	0	0
Indian	1	1	2	16.7	0.6
Others	1	2	3	25.0	2.3
Foreigners	2	3	5	41.6	0.3
Total	**4**	**8**	**12**	**100**	**0.2**

^ Excluded four foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

The 11 cases acquired the infection from South Asia (54.6%), Southeast Asia (36.4%) and Australia (9.1%) (Table 4.18). Most Singapore residents acquired the disease while overseas on vacation (66.7%) (Table 4.19).

Table 4.18
Imported paratyphoid cases by country/ region of origin, 2016-2017

	2016	2017
	No. (%)	No. (%)
East Asia		
China	1 (5.9)	0
Southeast Asia		
Indonesia	1 (5.9)	4 (36.4)
Myanmar	6 (35.3)	0
South Asia		
Bangladesh	3 (17.6)	2 (18.2)
India	5 (29.4)	4 (36.3)
Pakistan	1 (5.9)	0
Others		
Australia	0	1 (9.1)
Total	**17 (100)**	**11 (100)**

Table 4.19
Singapore residents who contracted paratyphoid overseas, 2013-2017

Purpose of travel	2013		2014		2015		2016		2017	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Vacation	6	54.6	8	88.9	10	83.3	6	66.7	5	71.4
Business/employment	5	45.4	1	11.1	2	16.7	3	33.3	0	0
Others	0	0	0	0	0	0	0	0	2	28.6
Total	**11**	**100**	**9**	**100**	**12**	**100**	**9**	**100**	**7**	**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 81 cases of laboratory confirmed acute hepatitis A in 2017 as compared to 48 cases in 2016 (Figure 4.4). 32 were imported and 45 were indigenous cases. The remaining four cases involved two tourists and two foreigners seeking medical treatment in Singapore (Table 4.20).

Among local residents, the incidence of acute hepatitis A was highest in the 65+ years age group. The overall male to female ratio was 1.8:1 (Table 4.21). Among the three major ethnic groups, Indians had the highest incidence rate (Table 4.22).

Figure 4.4
Weekly distribution of reported acute hepatitis A cases, 2016-2017

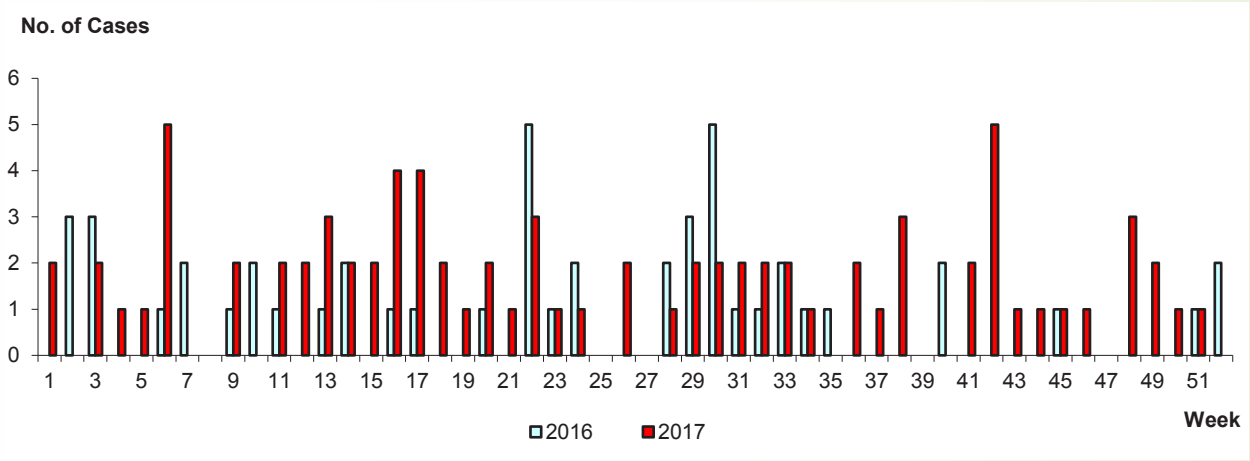


Table 4.20
Classification of reported acute hepatitis A cases, 2017

Population group	No. of cases (%)
Singapore residents	56 (69.1)
Work permit holders/other foreigners	21 (25.9)
Foreigners seeking medical treatment in Singapore	2 (2.5)
Tourists	2 (2.5)
Total	**81 (100)**

Table 4.21
Age-gender distribution and age-specific resident incidence rate of acute hepatitis A cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	4	1	5	6.5	0.7
15-24	4	4	8	10.4	1.0
25-34	21	4	25	32.4	2.3
35-44	7	2	9	11.7	1.0
45-54	4	3	7	9.1	1.1
55-64	5	4	9	11.7	1.4
65+	4	10	14	18.2	2.7
Total	**49**	**28**	**77**	**100**	

^Excluded two tourists and two foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 4.22
Ethnic-gender distribution and ethnic-specific incidence rate of acute hepatitis A cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	23	18	41	53.2	1.4
Malay	6	1	7	9.1	1.3
Indian	4	3	7	9.1	2.0
Others	1	0	1	1.3	0.8
Foreigners	15	6	21	27.3	1.3
Total	**49**	**28**	**77**	**100**	**1.4**

^Excluded two tourists and two foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Imported acute hepatitis A

Of the 81 cases of acute hepatitis A, 32 (39.5%) cases acquired the infection overseas (Table 4.23). The majority of the cases acquired the infection from Southeast Asia (54.5%) and South Asia (24.2%) (Table 4.24).

Table 4.23
Classification of imported acute hepatitis A cases, 2017

Population group	No. of cases (%)
Local residents	
Residents who contracted the disease overseas	18 (56.3)
Work permit/employment/dependent pass holders	10 (31.3)
Foreigners seeking medical treatment	2 (6.3)
Tourists	2 (6.3)
Total	**32 (100)**

Table 4.24
Imported acute hepatitis A cases by country/ region of origin, 2017

Country/ region of origin	No. of cases (%)
Southeast Asia	
Indonesia	3 (9.1)
Malaysia	4 (12.1)
Myanmar	2 (6.1)
Philippines	2 (6.1)
Cambodia	2 (6.1)
Viet Nam	2 (6.1)
Thailand	3 (9.1)
South Asia	
India	7 (21.2)
Sri Lanka	1 (3.0)
Others	
Hong Kong SAR	1 (3.0)
Taiwan	2 (6.1)
Australia	2 (6.1)
Republic of Korea	1 (3.0)
Uzbekistan	1 (3.0)
Total	**33 (100)**

*count is higher than table 4.23 as some individuals visited more than one country

Table 4.25
Total number of notifications* received for acute hepatitis A, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0–4	0	0	0	1	0	0	0	0	0	0
5–14	1	6	0	4	0	4	0	3	3	2
15–24	2	7	3	8	5	7	1	5	5	5
25–34	4	15	7	17	2	11	1	13	14	12
35–44	10	5	2	8	4	5	1	5	5	5
45–54	7	9	0	7	2	1	2	2	3	4
55–64	2	5	1	1	1	1	1	0	5	4
65+	4	0	8	0	2	0	2	2	14	0
Total	**30**	**47**	**21**	**46**	**16**	**29**	**8**	**30**	**49**	**32**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

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 76[1] reported cases of serologically confirmed acute hepatitis E in 2017, compared to 74[1] cases in 2016 (Figure 4.5). They comprised 61 Singapore residents, nine work permit holders, five foreigners seeking medical treatment in Singapore and one tourist (Table 4.26). Among Singapore residents and work permit holders, 58 were local and 12 were imported cases.

Among local residents, the incidence of acute hepatitis E was highest in the 65+ years age group (4.3 per 100,000 population). The overall male to female ratio was 2:1 (Table 4.27). Of the three main ethnic groups, Chinese had the highest incidence (Table 4.28).

[1] Case definition for an acute Hepatitis E was updated in October 2016.

Figure 4.5
Weekly distribution of reported acute hepatitis E cases, 2016-2017

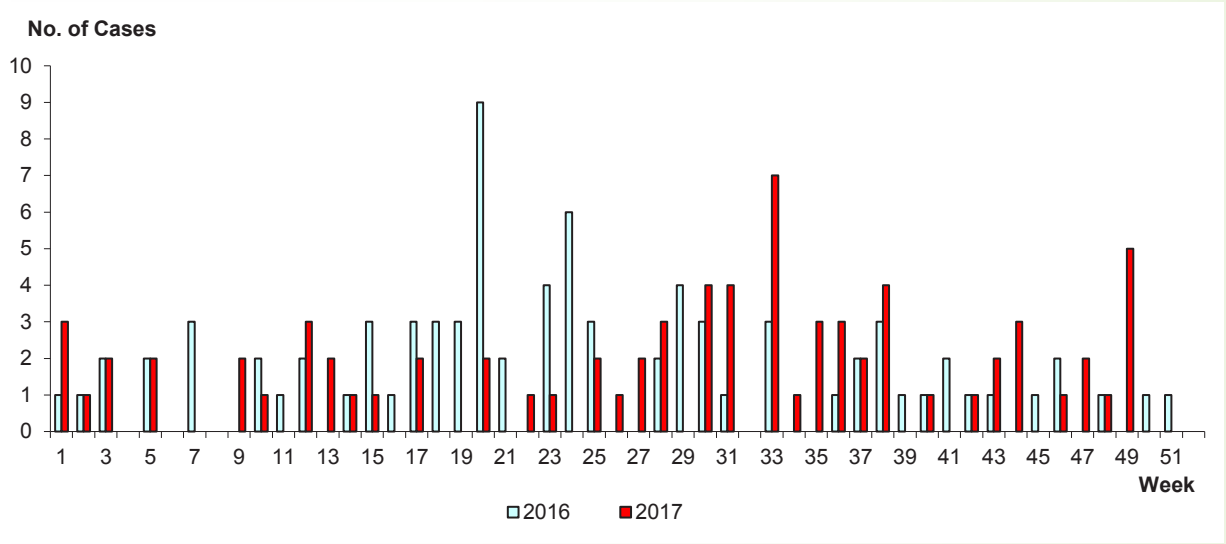


Table 4.26
Classification of reported acute hepatitis E cases, 2017

Population group	No. of cases (%)
Singapore residents	61 (80.3)
Work permit holders/other foreigners	9 (11.8)
Foreigners seeking medical treatment in Singapore	5 (6.6)
Tourists	1 (1.3)
Total	**76 (100)**

Table 4.27
Age-gender distribution and age-specific resident incidence rate of acute hepatitis E cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	2	2	4	5.7	0.6
25-34	9	3	12	17.2	1.2
35-44	3	2	5	7.1	0.5
45-54	4	2	6	8.6	0.8
55-64	15	6	21	30.0	3.7
65+	14	8	22	31.4	4.3
Total	**47**	**23**	**70**	**100**	

^ Excluded one tourist and five foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 4.28
Ethnic-gender distribution and ethnic-specific incidence rate of acute hepatitis E cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	38	19	57	81.4	1.9
Malay	1	0	1	1.4	0.2
Indian	1	2	3	4.3	0.8
Others	0	0	0	0	0
Foreigners	7	2	9	12.9	0.5
Total	**47**	**23**	**70**	**100**	**1.2**

^ Excluded one tourist and five foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Imported acute hepatitis E

Of the 76 cases of hepatitis E, 18 (23.7%) cases acquired the infection overseas (Table 4.29). The majority of the cases acquired the infection from the South Asia (55.6%) and Southeast Asia (38.9%) (Table 4.30).

Table 4.29
Imported acute hepatitis E cases by population group, 2017

Population group	No. of cases (%)
Local residents	
Residents who contracted the disease overseas	4 (22.2)
Work permit/employment/dependent pass holders	8 (44.4)
Foreigners seeking medical treatment	5 (27.8)
Tourists	1 (5.6)
Total	**18 (100)**

Table 4.30
Imported acute hepatitis E cases by country/ region of origin, 2017

Country/ region of origin	No. of cases (%)
Southeast Asia	
Indonesia	1 (5.6)
Malaysia	3 (16.6)
Philippines	1 (5.6)
Thailand	2 (11.0)
South Asia	
Bangladesh	9 (50.0)
India	1 (5.6)
Others	
Hong Kong SAR	1 (5.6)
Total	**18 (100)**

After excluding tourists and foreigners seeking medical treatment in Singapore, the annual number of acute hepatitis E notifications in the past five years has ranged from 18-58 for local cases and 12-35 for imported cases (Table 4.31).

Table 4.31
Total number of notifications* received for acute hepatitis E cases, 2013-2017

Age group	2013		2014		2015		2016		2017	
	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	1	0	0	0
15-24	0	8	0	1	0	5	0	0	3	1
25-34	2	9	3	5	1	3	0	4	7	5
35-44	3	5	1	8	2	1	6	2	4	1
45-54	2	2	6	2	9	0	9	2	5	1
55-64	4	6	17	3	17	6	17	6	19	2
65+	7	5	15	2	13	1	23	2	20	2
Total	**18**	**35**	**42**	**21**	**42**	**16**	**56**	**16**	**58**	**12**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Hepatitis E virus genotypes

In 2017, 112 laboratory-confirmed acute hepatitis E samples were forwarded to the National Public Health Laboratory for genotyping. 44 of 112 samples were PCR positive and the remaining 68 samples were positive by serology only.

Among the 44 PCR positive samples, 41 were indigenous cases and three were imported cases. Of the 41 indigenous cases, 18 (43.9%) were genotype 3, three (7.3%) were genotype 1 and the genotypes for remaining samples were indeterminate. Of the three imported cases, one (33.3%) was genotype 1 and the genotypes for 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 2,010 laboratory confirmed cases of non-typhoidal salmonellosis were reported in 2017, a decrease of 9.1% compared to 2,212 cases reported in 2016 (Figure 4.6). *Salmonella* Group D was the predominant serogroup identified in 2017 (Table 4.32). Of these Group D cases, 295 cases were caused by *S.* Enteritidis.

Figure 4.6
Weekly distribution of reported salmonellosis cases, 2016-2017

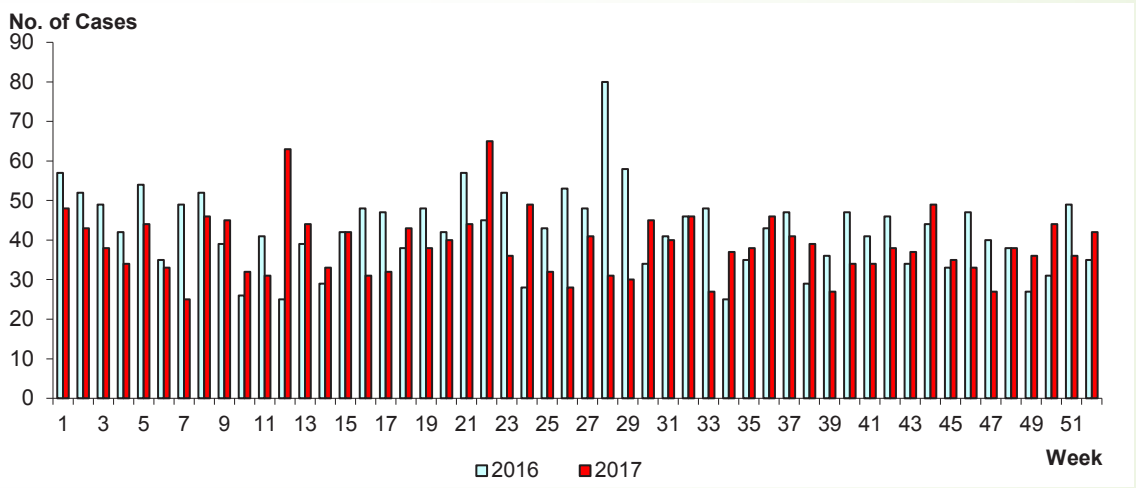


Table 4.32
Reported salmonellosis cases by serogroups, 2017

Salmonella serogroups	No. of cases	Incidence rate per 100,000 population*
Enterica-D	795	14.2
Enterica-B	457	8.1
Enterica-C	236	4.2
Enterica-E	85	1.5
Enterica-E/G	23	0.4
Enterica-G	2	0
Enterica-A	1	0
Enterica-Unspecified	411	7.3
Grand Total	**2,010**	**35.8**

*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

***Salmonella* Enteritidis**

Of the 295 cases reported in 2017, 290 were local residents comprising 276 indigenous and 14 imported cases. The remaining five cases involved four foreigners seeking medical treatment in Singapore and one tourist.

The notifications of *S.* Enteritidis among local residents had decreased by 5.5% as compared to 307 cases in 2016 (Table 4.33). The incidence rate was highest in the 65+ years age group (Table 4.34).

Table 4.33
Total number of notifications* received for reported *S.* Enteritidis cases, 2013-2017

	2013		2014		2015		2016		2017	
Age group	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	124	3	71	0	34	0	21	1	27	1
5-14	36	0	15	1	16	1	7	0	6	0
15-24	22	0	20	0	12	1	19	1	21	0
25-34	80	1	35	1	34	0	40	2	22	2
35-44	29	2	28	0	34	0	30	0	31	1
45-54	30	3	36	1	35	0	42	0	28	2
55-64	55	4	61	2	54	2	40	1	35	4
65+	137	4	116	1	101	0	103	0	106	4
Total	**513**	**17**	**382**	**6**	**320**	**4**	**302**	**5**	**276**	**14**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Table 4.34
Age-gender distribution and age-specific resident incidence rate of reported *S.* Enteritidis cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	14	14	28	9.7	12.8
5-14	5	1	6	2.1	1.5
15-24	9	12	21	7.2	2.2
25-34	16	8	24	8.3	2.5
35-44	21	11	32	11.0	3.8
45-54	18	12	30	10.3	4.7
55-64	26	13	39	13.5	6.4
65+	69	41	110	37.9	20.7
Total	**178**	**112**	**290**	**100**	

*Excluded one tourist and four foreigners seeking medical treatment in Singapore.
**Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Among the three major ethnic groups, Malays had the highest incidence rate, followed by Chinese and Indians (Table 4.35).

Table 4.35
Ethnic-gender distribution and ethnic-specific incidence rate of reported *S.* Enteritidis cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	104	67	171	59.0	5.8
Malay	40	16	56	19.3	10.6
Indian	9	9	18	6.2	5.0
Others	3	2	5	1.7	3.9
Foreigners	22	18	40	13.8	2.4
Total	**178**	**112**	**290**	**100**	**5.2**

*Excluded one tourist and four foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

FOOD POISONING

There were 347 notifications of food poisoning involving 1,825 cases in 2017, compared with 431 notifications with 2,502 cases in 2016 (Figure 4.7).

Figure 4.7
Notifications of food poisoning in Singapore, 1965-2017

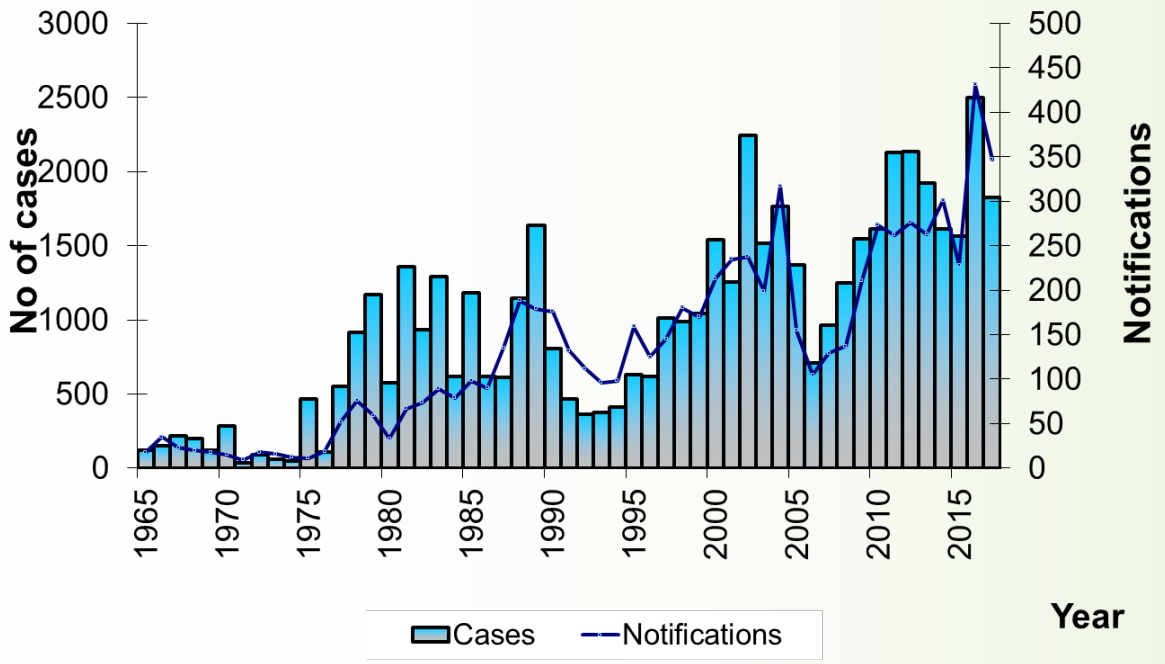


Table 4.36
Food poisoning notifications by type of food establishments, 2017

Type of food establishments	No. of notifications	No. of food establishments involved	No. of cases
General outlets			
Bakery	4	4	20
Canteens			
School	5	5	116
Tertiary Institution	0	0	0
Others	3	3	17
Caterer (licensed)	13	13	306
Eating house	29	29	70
Fair (food fair)	1	1	2
Fair (others)	2	2	7
Food court	27	27	72
Foodshop (takeaway)	10	9	30
Hawker centre	20	20	134
Other licensed premises	1	1	2
Restaurants			
In Hotel	26	16	169
Fast Food	12	12	48
Others	169	152	649
Supermarket	5	5	17
Snackbar	9	9	30
Food factory	4	3	70
Sub-total (General outlets)	**340**	**311**	**1,759**
In house kitchens			
Army	0	0	0
Childcare centre	2	2	9
Hotel	1	1	12
Nursing home	0	0	0
Police	0	0	0
Prison	0	0	0
School	1	1	33
Workers dormitory	0	0	0
Others	3	3	12
Unlicensed premises	0	0	0
Sub-total (Others)	**7**	**7**	**66**
Total	**347**	**318**	**1,825**

In the course of epidemiological investigation into food poisoning incidents, a total of 213 food samples and 53 environment swabs were taken and sent for microbiological analysis.

Of the food samples, six were positive for *Escherichia coli,* four for *Bacillus cereus*, two for *Staphylococcus aureus*, and one for *Vibrio parahaemolyticus*.

Of the environment swabs, one was tested positive for *Bacillus cereus.*

Of 329 food handlers sent for screening, four were positive for norovirus, two for rotavirus and one each for *Campylobacter jejuni, Plesiomonas shigelloides, Salmonella* enteritidis, *Vibrio fluvalis*, *Vibrio furnissii, Vibrio parahaemolyticus;* and *Vibrio* species.

CHAPTER 5

BLOOD-BORNE & SEXUALLY TRANSMITTED DISEASES

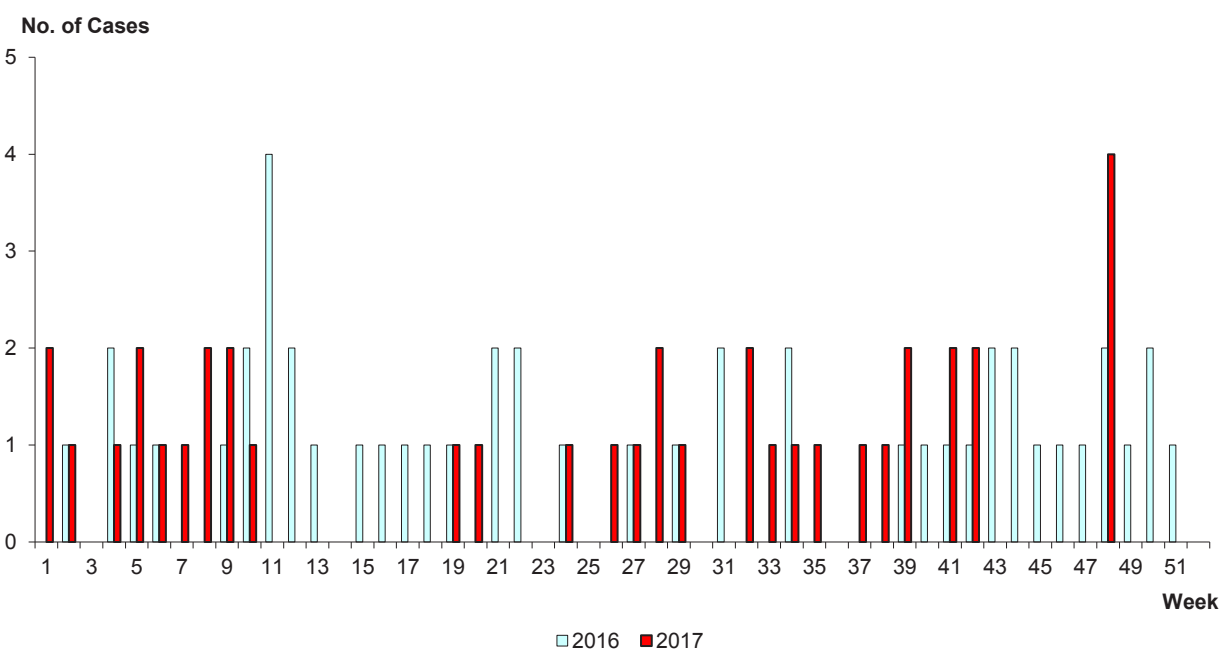
Exposure to blood and other body fluids can transmit diseases. Sexually transmitted infections (STIs) are spread predominantly by sexual contact, sometimes through non-sexual means such as via blood or blood products. STIs can have serious health consequences beyond the immediate impact of the infection 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 38 cases of acute hepatitis B were reported in 2017, compared to 47 cases reported in 2016 (Figure 5.1). All cases were serologically confirmed with the presence of hepatitis B surface antigen and anti-HBc IgM antibody which is associated with acute clinical presentation.

Figure 5.1
Weekly distribution of reported acute hepatitis B cases, 2016-2017



The resident incidence rate was highest in the 35-44 years age group and an overall male to female ratio among cases was 2.8:1 (Table 5.1). Among the three major ethnic groups, Chinese had the highest incidence rate (Table 5.2). The majority of the cases (89.5%) were local cases (Table 5.3).

Table 5.1
Age-gender distribution and age-specific resident incidence rate of acute hepatitis B cases, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	1	2	3	7.9	0.2
25-34	7	1	8	21.1	0.7
35-44	10	4	14	36.8	1.6
45-54	8	0	8	21.1	1.1
55-64	1	0	1	2.6	0.2
65+	1	3	4	10.5	0.8
Total	**28**	**10**	**38**	**100**	

*Rates are based on 2017 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, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	17	5	22	57.9	0.7
Malay	2	1	3	7.9	0.6
Indian	1	0	1	2.6	0.3
Others	1	0	1	2.6	0.8
Foreigners	7	4	11	29.0	0.7
Total	**28**	**10**	**38**	**100**	**0.7**

*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 5.3
Total number of notifications* received for acute hepatitis B cases, 2013-2017

Age Group	2013		2014		2015		2016		2017	
	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	2	0	1	1	0	0	3	0	2	1
25-34	15	6	12	3	19	1	13	0	8	0
35-44	14	2	10	1	14	1	14	2	11	3
45-54	9	0	8	2	7	0	5	2	8	0
55-64	3	0	4	3	6	0	5	0	1	0
65+	4	0	1	2	2	0	2	0	4	0
Total	**47**	**8**	**36**	**12**	**48**	**2**	**42**	**4**	**34**	**4**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

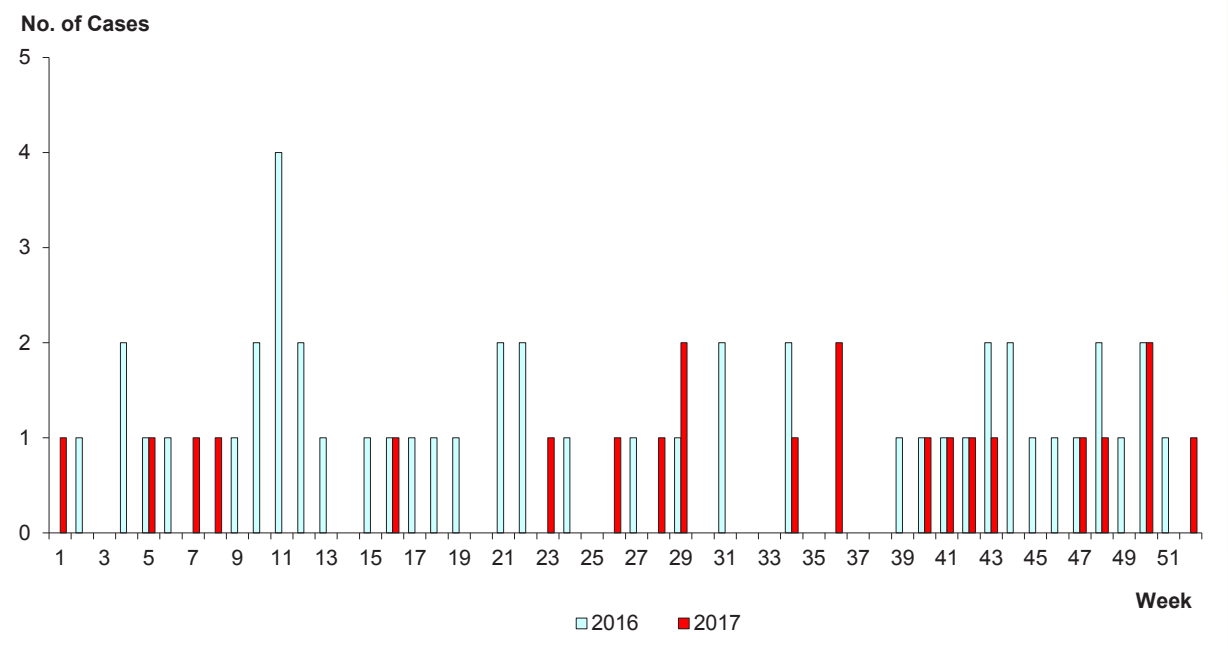
A total of 19,697 blood samples were screened at the KK Women's and Children's Hospital for HBsAg and HBeAg in 2017. Of these, 342 (1.7%) were HBsAg positive and 84 (0.4%) were HBeAg positive.

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 Anti-Virals (DAAs) is effective but costly.

A total of 22 cases of acute hepatitis C were reported in 2017, compared to 24 cases reported in 2016 (Figure 5.2).

Figure 5.2
Weekly distribution of reported acute hepatitis C cases, 2016-2017



The resident incidence rate was highest in the 45-54 years age group and an overall male to female ratio among cases was 6.3:1 (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, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0- 4	0	0	0	0	0
5-14	0	0	0	0	0
15-24	1	1	2	9.1	0.4
25-34	3	0	3	13.6	0.5
35-44	6	0	6	27.3	0.8
45-54	6	0	6	27.3	1.1
55-64	2	1	3	13.6	0.5
65+	1	1	2	9.1	0.4
Total	**19**	**3**	**22**	**100**	

*Rates are based on 2017 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, 2017

	Male	Female	Cases	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	9	2	11	50	0.4
Malay	6	1	7	31.8	1.3
Indian	0	0	0	0	0
Others	4	0	4	18.2	3.1
Foreigners	0	0	0	0	0
Total	**19**	**3**	**22**	**100**	**0.4**

Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 5.6
Total number of notifications* received for acute hepatitis C cases, 2013-2017

Age Group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	0	0	0	1	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0
15-24	0	0	0	0	4	0	2	0	2	0
25-34	0	0	0	0	7	0	2	1	3	0
35-44	0	0	1	0	5	0	6	0	5	0
45-54	1	0	2	1	12	0	4	0	7	0
55-64	1	0	1	0	15	0	5	0	3	0
65+	0	0	0	0	2	0	2	0	2	0
Total	**2**	**0**	**4**	**1**	**45**	**0**	**22**	**1**	**22**	**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 AIDS Update for 2017, there were an estimated 1.8 million new HIV infections and 36.7 million people globally living with HIV at the end of 2016.

HIV can be transmitted from person to person through unprotected sexual intercourse, the use of HIV contaminated needles including the sharing of needles among intravenous drug users, transfusion of infected blood or blood products, mucosal exposures with infected body fluid 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, when a person's immune system is severely damaged and vulnerable to opportunistic infections. Previously, people 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 lifespan of an HIV infected individual 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 Communicable Disease Centre, 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 434 new HIV infections were reported among Singapore residents in 2017, compared to 408 cases in 2016 (Table 5.7). This brings the cumulative total number of HIV/AIDS infections among residents since the first case was diagnosed in 1985 to 7,982, of which 1,960 had died. 41% of the newly reported patients presented with late-stage[1] HIV infection. The notification rate of HIV/AIDS in 2017 was 10.9 per 100,000 population, compared to 10.4 per 100,000 population in 2016 (Table 5.7). In 2017, 72 deaths in HIV/AIDS patients were reported giving a mortality rate of 18.2 per million population.

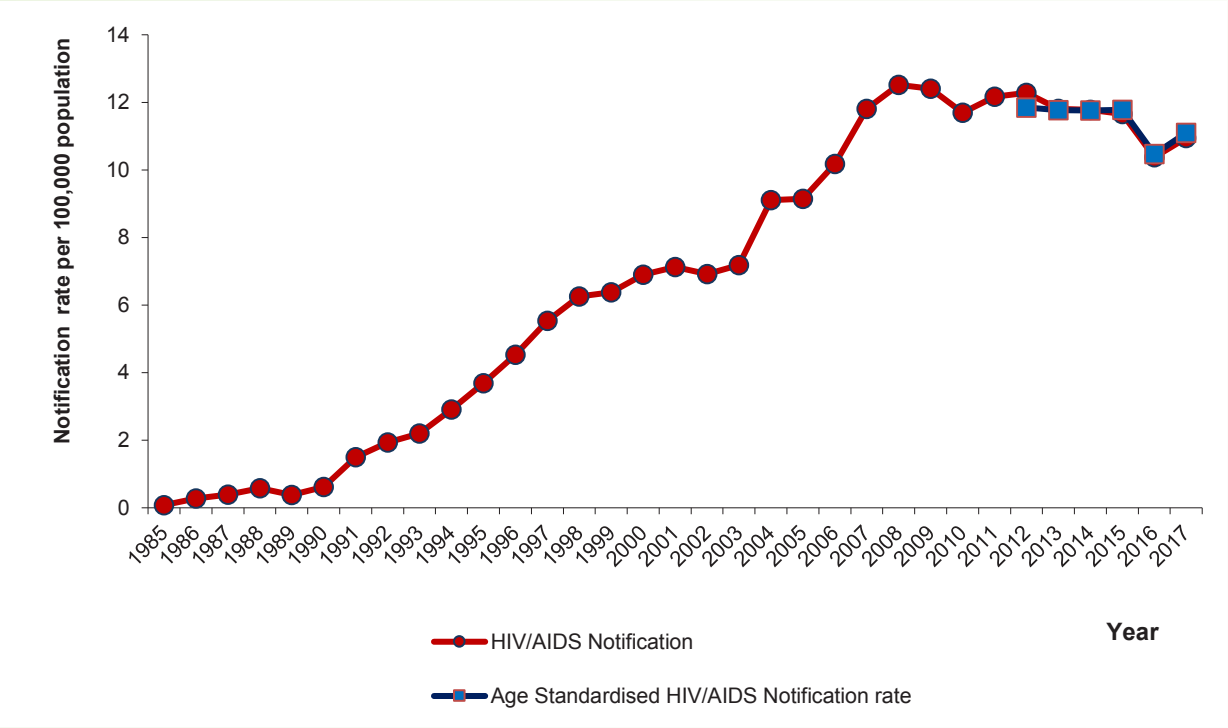
[1] Defined by CD4+ cell count of less than 200 per cu mm OR AIDS-defining opportunistic infections OR both.

Table 5.7
Distribution of Singapore residents with HIV/AIDS by gender, 1985-2017

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
Total	**7,287**	**695**	**7,982**	

*Prior to 2017, the notification rate was reported per million population instead of per 100,000.

Figure 5.3
Notification rate of HIV/AIDS in Singapore residents, 1985-2017



Distribution by age and gender

As in previous years, HIV/AIDS cases were predominantly male, with a male to female ratio of 16:1. In 2017, the highest notification rate were observed for males in the 30-39 years age group and for females in the 20-29 years age group (Table 5.8).

Table 5.8
Age-gender distribution and age-specific notification rate of HIV/AIDS in Singapore residents, 2017

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	7	1	8	1.8	5.9	0.9	3.4
20-29	95	7	102	23.5	34.6	2.5	18.6
30-39	97	3	100	23.0	35.3	1.0	17.2
40-49	98	6	104	24.0	32.8	1.9	16.9
50-59	79	5	84	19.4	25.7	1.6	13.7
60+	32	4	36	8.3	8.8	1.0	4.6
Total	**408**	**26**	**434**	**100**			
Crude rate					**21.0**	**1.3**	**10.9**
Age-standardised rate					**21.4**	**1.3**	**11.1**

*Prior to 2017, the notification rate was reported per million population instead of per 100,000.
Rates are based on 2017 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 25.4 per 100,000 population, followed by Chinese (Table 5.9).

Table 5.9
Ethnic-gender distribution and ethnic-specific notification rate of HIV/AIDS in Singapore residents, 2017

Ethnic group	Male	Female	Total	%	Notification rate per 100,000 population*		
					Male	Female	Total
Chinese	293	6	299	68.9	20.4	0.4	10.1
Malay	67	15	82	18.9	25.4	5.6	15.5
Indian	24	3	27	6.2	13.1	1.7	7.5
Others	24	2	26	6.0	40.3	2.9	20.3
Total	**408**	**26**	**434**	**100**	**21.0**	**1.3**	**10.9**

*Prior to 2017, the notification rate was reported per million population instead of per 100,000.
Rates are based on 2017 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 96% of cases in 2017 (Table 5.10). Heterosexual transmission accounted for 35.7% of all cases in 2017, while homosexual and bisexual transmission accounted for 60.4%.

Table 5.10
Distribution of Singapore residents with HIV/AIDS by mode of transmission, 2017

Mode of transmission	No.	%
Sexual Transmission		
Heterosexual	155	35.7
Homosexual	218	50.2
Bisexual	44	10.2
Intravenous drug use	0	0
Blood Transfusion	0	0
Renal Transplant overseas	0	0
Perinatal (mother to child)*	1	0.2
Uncertain/Others	16	3.7
Total	**434**	**100**

*Transmission occurred overseas

Mode of detection

About 45.2% of the newly reported cases were detected by HIV tests done in the course of medical care provisioning. Another 27.2% were detected during routine programmatic HIV screening while 22.8% 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, 2017

Mode of detection	No.	%
Medical care*	196	45.2
Routine programmatic HIV screening^	118	27.2
Voluntary	99	22.8
Others/Uncertain	21	4.8
Total	**434**	**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 2017, a total of 394 HIV cases (excluding those who had died or were in prison) were identified for contact tracing. Of these, 363 cases were interviewed. The remaining cases were hospitalised, overseas or pending interview (as at 31 December 2017).

A total of 61 spouses (excluding spouses who had died, were divorced or overseas) were identified for notification under the spousal notification programme. Of these, 58 cases were notified. The remaining spouses were not notified as it was assessed that there was no ongoing risk of transmission.

A total of 307 sexual contacts were reported during contact tracing interviews conducted among cases diagnosed. Of these, 172 contacts were contactable, notified of their exposure to HIV, and advised to undergo testing. 102 of these notified contacts reported that they tested for HIV, and 18 of those tested were 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 2017, the prevalence of HIV infection among cases tested in anonymous test sites was highest, at 1.1%, followed by inpatient opt-out testing and antenatal screening, at 0.2% and 0.1% respectively.

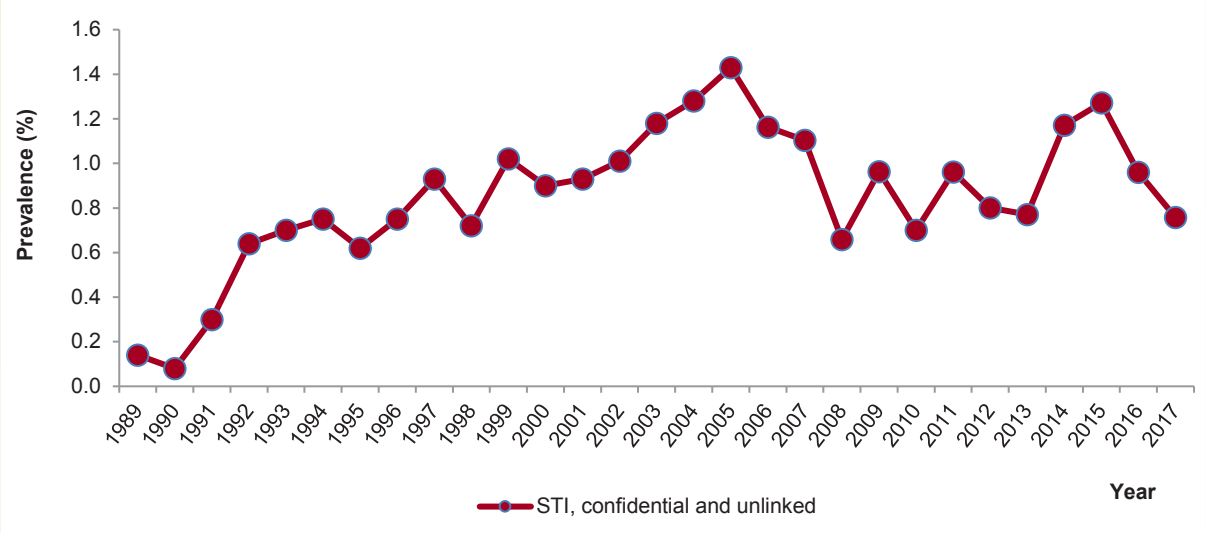
Table 5.12
Results for HIV surveillance programmes, 2013-2017

Programme		2013	2014	2015	2016	2017
Anonymous test sites	Total number of tests done	13,893	15,950	15,641	17,781	17,363
	Number tested positive	227	202	223	179	182
	Percentage tested positive (%)	1.6	1.3	1.4	1.0	1.1
Inpatient opt-out testing	Total number of tests done	33,297	30,834	30,123	28,684	28,724
	Number tested positive	41	58	49	49	58
	Prevalence (%)	0.1	0.2	0.2	0.2	0.2
Antenatal screening	Total number of tests done	38,088	38,679	33,945	27,498	27,347
	Number tested positive	13	20	19	10	14
	Prevalence (%)	0	0.1	0.1	0	0.1

Unlinked anonymous HIV seroprevalence surveillance

One sentinel population is currently monitored through unlinked anonymous testing to monitor HIV seroprevalence. These are the patients with sexually transmitted infections (STIs) who are seen at the Department of STI Control (DSC) clinic. The HIV seroprevalence among all STI attendees decreased slightly from 1.0% in 2016 to 0.8% in 2017 (Figure 5.4).

Figure 5.4
Unlinked anonymous HIV seroprevalence, 1989-2017



HIV molecular surveillance

In 2017, 23.8% 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). As in previous years, the proportion of recent infections remained relatively stable (Table 5.13). Virological surveillance of HIV strains among these recently-infected individuals revealed the predominant circulating subtype was CRF01_AE (52.6%), followed by subtype B (34.2%). The overall prevalence of transmitted drug resistance (TDR) to any antiretroviral (ARV) class was 3.1%. Transmitted resistance to nucleoside reverse transcriptase inhibitors (NRTIs), non-nucleoside reverse transcriptase inhibitors (NNRTIs) and protease inhibitors (PIs) were 1.3%, 1.9% and 1.3% respectively.

Table 5.13
Results for HIV molecular surveillance programme, 2013-2017

HIV molecular surveillance	**2013**	**2014**	**2015**	**2016**	**2017**
Total number of samples tested	123	118	116	245	160
Recent infections (%)	17.1	17.8	22.4	20.4	23.8
Circulating subtypes (%)					
CRF01_AE	47.6	60.0	61.5	64.0	52.6
Subtype B	42.9	40.0	34.6	24.0	34.2
Transmitted Drug Resistance					
Any drug class (%)	3.3	3.4	7.0	3.7	3.1
NRTI (%)	2.4	1.7	0.9	0.8	1.3
NNRTI (%)	0.8	1.7	2.6	3.3	1.9
PI (%)	0	0	3.5	0.8	1.3

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 papilloma virus (anogenital warts), *Trichomonas vaginalis* (infection of the urethra and vagina) and human immunodeficiency virus (HIV).

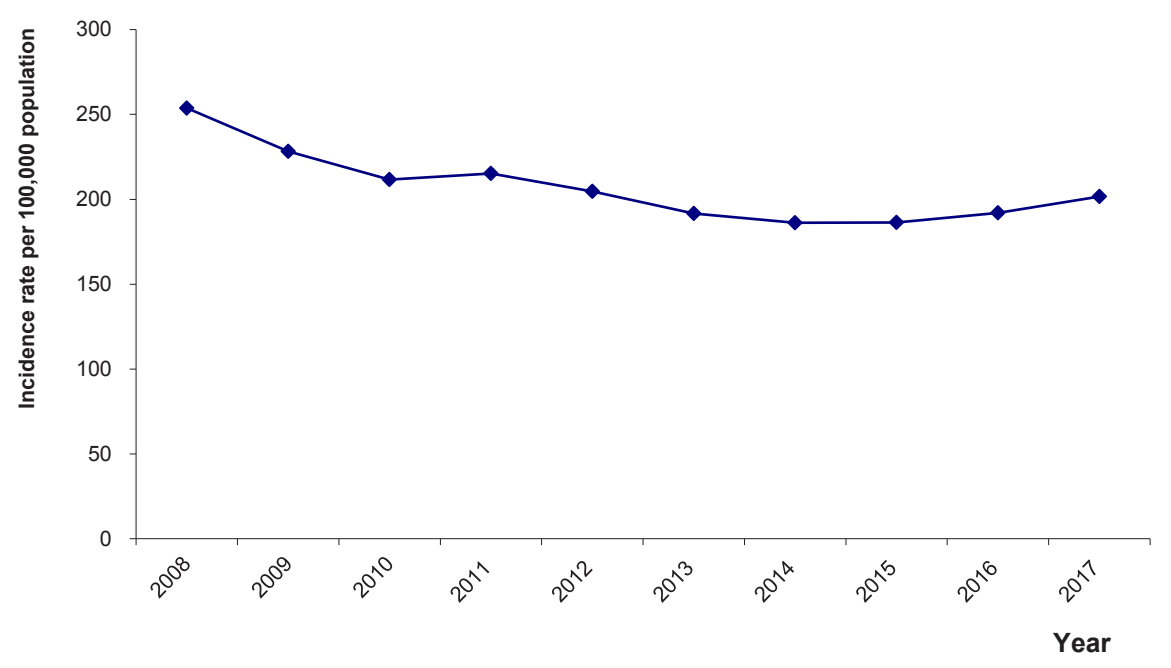
The diagnosis of an STI is a “sentinel” event which indicates unprotected sexual activity and therefore, patients presenting with one STI are at increased risk of acquisition of others. The presence of STIs can increase the risk of acquisition of HIV infection and also promote its transmission. Sexually 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 increased from 192 per 100,000 population in 2016 to 201.6 per 100,000 population in 2017. (Figure 5.5). The three main bacterial STIs notified in 2017 were chlamydia, gonorrhoea and syphilis.

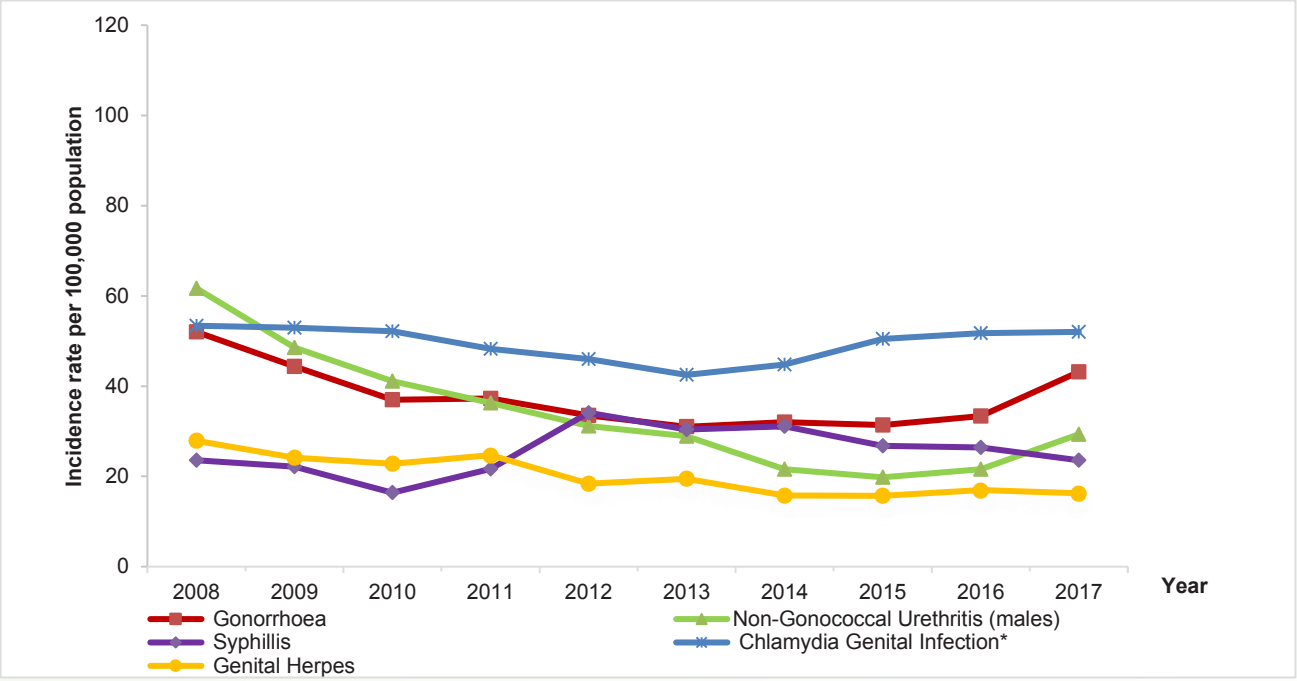
Figure 5.5
Incidence rate of STIs, 2008-2017



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 rate of individual legally notifiable STIs are shown in Figure 5.6.

Figure 5.6
Incidence rate of legally notifiable STIs*, 2008-2017



* 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, 2017

STIs	Incidence rate per 100,000 population*		
	Male	Female	Total
Legally Notifiable STIs			
Chlamydia	64.2	39.0	52.0
Gonorrhoea	69.4	15.2	43.2
Non-Gonococcal Urethritis (NGU)	29.3	NA	
Syphilis	35.2	11.2	23.6
Genital herpes	20.1	12.3	16.3
Other STIs			
Vaginal discharge^	NA	16.4	
Candidiasis	4.2	16.8	10.3
Genital warts	30.0	7.1	18.9
Mucopurulent cervicitis (MPC)	NA	16.6	
Chancroid	0	0	0
Others	6.9	5.5	6.2
Total	**259.4**	**140.0**	**201.6**

*Rates are based on 2017 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 209 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, 2017

Ethnic group	Male	Female	Total	%	Incidence rate per 100,000 population*		
					Male	Female	Total
Chinese	4,252	1,796	6,048	74.4	296.0	118.8	205.1
Malay	674	435	1,109	13.6	255.4	163.0	209.0
Indian	381	110	491	6.0	207.3	62.9	136.8
Others	327	155	482	6.0	549.3	226.3	376.5
Total	**5,634**	**2,496**	**8,130**	**100**	**289.9**	**123.4**	**205.0**

*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Chlamydia

Chlamydia is the most common cause of NGU. Since 2006, there have been more cases of NGU tested for *Chlamydia trachomatis*. The incidence of chlamydia has shown an increase in males and a slight decrease in females in 2017 (64.2 and 39 per 100,000 population respectively), compared to 2016 (62.6 and 39.9 per 100,000 population respectively) (Table 5.14).

Syphilis

The incidence rate of syphilis was 23.6 per 100,000 population in 2017 compared to 26.4 in 2016.

The incidence rate of infectious syphilis was between 2.4 to 6.2 per 100,000 population from 1996 to 2016. In 2017, the incidence rate of infectious syphilis was 6.6 per 100,000 population compared to 6.2 in 2016. There were no cases of congenital syphilis reported in 2017.

Gonorrhoea

The incidence rate of gonorrhoea was 43.2 per 100,000 population in 2017 compared to 33.4 in 2016. There were no cases of gonococcal ophthalmia neonatorum reported in 2017.

The percentage of gonorrhoea cultures with decreased susceptibility to ceftriaxone was 5.4% in 2017 compared to 6.3% in 2016. (Table 5.16).

The percentage of *Neisseria gonorrhoeae* cultures resistant to ciprofloxacin was 87.5% in 2017 compared to 81.9% in 2016. (Table 5.17).

Table 5.16
Susceptibility of gonorrhoea cultures to ceftriaxone, 2008-2017*

Year	No. of gonorrhoea cultures	Decreased Susceptibility (%)	Susceptible (%)
2008	160	0	100
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	6.3	93.8
2017	239	5.4	94.7

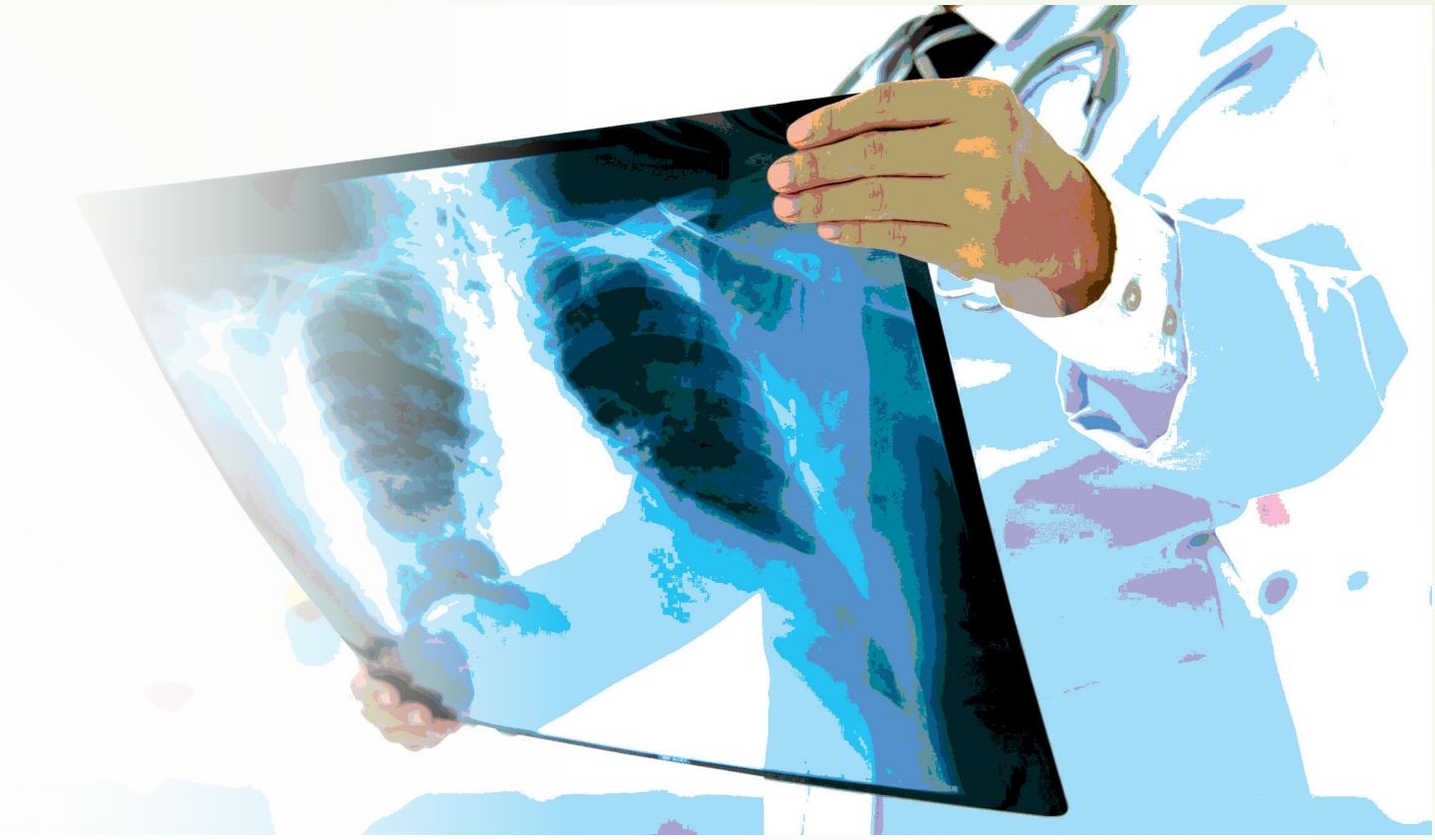
* Prior to 2017, the percentage of penicillinase-producing *Neisseria gonorrhoeae* (PPNG) detected among gonorrhoea positive cultures screened was reported. As penicillin is no longer used in the treatment of gonorrhoea with effect from 2017, susceptibility of gonorrhoea to ceftriaxone is reported instead.

Table 5.17
Gonorrhoea cultures screened for resistance to ciprofloxacin, 2008-2017

Year	No. of cultures	Ciprofloxacin resistant cases	
		No.	(%)
2008	160	119	74.4
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

CHAPTER 6

OTHER DISEASES



Tuberculosis is one of the top ten causes of death worldwide, and most often affects the lungs while leprosy is another 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 19 cases of laboratory-confirmed legionellosis were reported in 2017, compared with 12 cases in 2016 (Figure 6.1). 16 of these 19 cases were local residents, while the remaining three included one tourist and two foreigners seeking medical treatment in Singapore. 17 cases had confirmed Legionnaires' disease, one case had confirmed Pontiac fever and one case had presumptive Legionnaires' disease (Table 6.1). Three of the 16 cases had acquired the infections overseas (Table 6.3).

Figure 6.1
Weekly distribution of reported legionellosis cases, 2016-2017

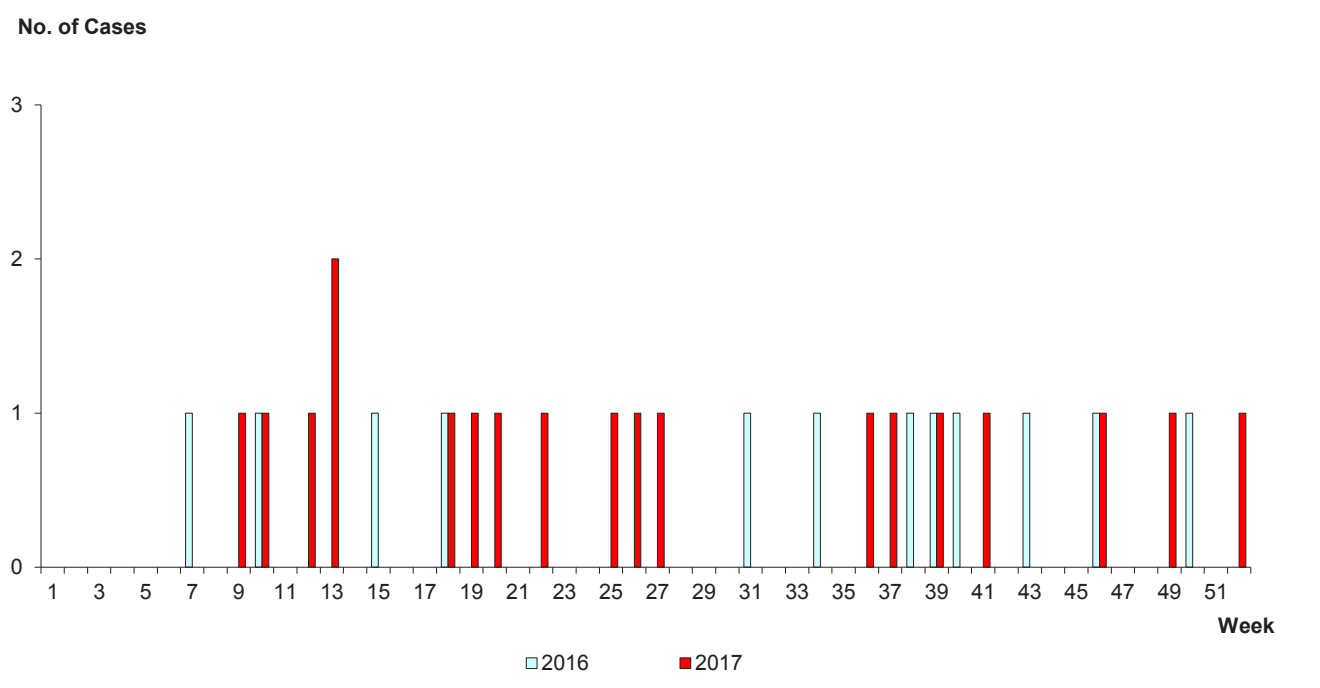


Table 6.1
Classification of reported legionellosis cases, 2017

	Pontiac fever	Legionnaires' disease	Total
Confirmed cases	1	17	18
Presumptive cases	0	1	1
Total	**1**	**18**	**19**

The resident incidence rate was highest among the 65+ years age group (Table 6.2).

Table 6.2
Age-gender distribution and age-specific resident incidence rate of reported legionellosis cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
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	2	0	2	12.5	0.2
45-54	2	0	2	12.5	0.3
55-64	2	1	3	18.8	0.5
65+	7	2	9	26.2	1.6
Total	**13**	**3**	**16**	**100**	

^Excluded two foreigners seeking medical treatment in Singapore and one tourist.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 6.3
Total number of notifications* received for legionellosis cases, 2013-2017

Age group	2013		2014		2015		2016		2017	
	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	1	0	0	0	0	0	0	0
35-44	1	0	2	1	0	0	1	0	2	0
45-54	3	0	1	1	2	0	1	0	2	0
55-64	6	2	4	0	3	0	2	1	2	1
65+	4	2	19	2	11	1	4	0	7	2
Total	**15**	**4**	**27**	**4**	**16**	**1**	**8**	**1**	**13**	**3**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Among the three major ethnic groups, Malays had the highest incidence rate of 0.6 per 100,000 population (Table 6.4). Various occupational groups were also affected (Table 6.5).

Table 6.4
Ethnic-gender distribution and ethnic-specific incidence rate of legionellosis cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	10	2	12	75.0	0.4
Malay	2	1	3	18.7	0.6
Indian	0	0	0	0	0
Others	1	0	1	6.3	0.8
Foreigners	0	0	0	0	0
Total	**13**	**3**	**16**	**100**	**0.3**

^Excluded one tourist and two foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 6.5
Occupations of reported legionellosis cases, 2017*

Occupation	No. of cases (n=16)
Drivers-Taxi/Bus/MRT & Deliveryman	1
Housewife	1
Labourers & Related Workers Not Classified	2
Lawyers & related workers	1
Managers	1
Retiree	3
Self-employed/Businessmen	1
Shop Sales & Related Workers	1
Unemployed	2
Information Technology Professionals	1
Technicians/Asst Engineers	1
Others	1

*According to Singapore Standard Occupational Classification 2000 (Department of Statistics).

Key presenting symptoms of the 16 legionellosis cases included fever, cough and chills (Table 6.6).

Table 6.6
Clinical presentation of reported legionellosis cases^, 2017*

Clinical presentation	No. of cases (n=16)
Fever (with/without chills and rigors)	16
Respiratory symptoms	
Cough (productive and non-productive)	12
Shortness of breath	3
Other signs and symptoms	
Chills	4
Myalgia	2
Giddiness	2
Abdominal pain	2
Generalised weakness	3
Vomiting	2

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

Seven (43.8%) of the cases had known risk factors for legionellosis (Table 6.7). There was one legionellosis death reported.

Table 6.7
Number of cases with known risk factors for legionellosis^, 2017*

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

Table 6.8
Leprosy notifications among Singapore residents and non-residents, 2010-2017

Year	No. of cases		
	Resident (%)	Non-resident (%)	Total
2010	4 (30.8)	9 (69.2)	13
2011	5 (31.3)	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

Leprosy in Singapore residents

The incidence rate of leprosy among Singapore residents has declined over the past five decades. In 2017, there were no notifications for leprosy among Singapore residents (Table 6.9).

Table 6.9
Distribution of leprosy notifications among Singapore residents by gender, 2010-2017

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

Leprosy patients are classified into multibacillary and paucibacillary types. (Table 6.10).

Table 6.10
Distribution of leprosy notifications among Singapore residents by type of infection, 2010-2017

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

Leprosy in non-residents

The contribution of non-residents to the total number of cases has fluctuated over the years. In 2017, there were six non-residents (five males and one female) notified for leprosy (Table 6.11).

Table 6.11
Distribution of leprosy notifications among non-residents by gender, 2010-2017

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

In 2017, there were four cases of multibacillary leprosy and one case of paucibacillary leprosy among non-residents (Table 6.12).

Table 6.12
Distribution of leprosy notifications among non-residents by type of infection, 2010-2017

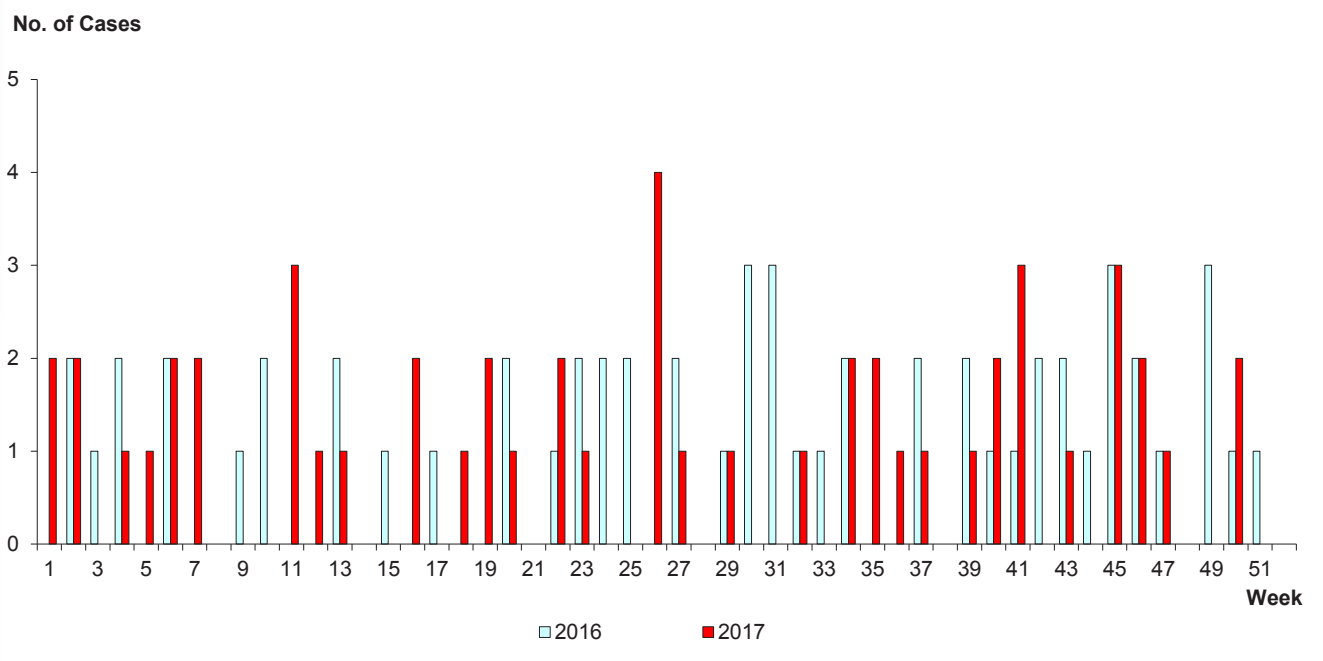
Year	Multibacillary	Paucibacillary	Unknown	Total
2010	4	5	0	9
2011	9	2	0	11
2012	6	4	0	10
2013	6	2	1	9
2014	2	2	1	5
2015	0	2	0	2
2016	2	3	0	5
2017	4	1	1	6

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 fulminant 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 52 cases of laboratory confirmed melioidosis in 2017, compared with 58 cases in 2016 (Figure 6.2). 47 of these were classified as indigenous cases and five were imported cases. The latter involved one Singapore resident, and four foreigners seeking medical treatment in Singapore (Table 6.15).

Figure 6.2
Weekly distribution of reported melioidosis cases, 2016-2017



The resident incidence rate was highest among the 65+ years age group (Table 6.13).

Table 6.13
Age-gender distribution and age-specific resident incidence rate of melioidosis cases^, 2017

Age group	Male	Female	Total	%	Resident incidence rate per 100,000 population*
0-4	0	0	0	0	0
5-14	1	0	1	2.1	0.2
15-24	2	0	2	4.2	0.2
25-34	2	0	2	4.2	0.2
35-44	3	0	3	6.2	0.2
45-54	12	1	13	27.1	1.6
55-64	8	0	8	16.6	1.6
65+	18	1	19	39.6	3.3
Total	**46**	**2**	**48**	**100**	

^Excluded four foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Among the three major ethnic groups, Malay had the highest incidence, followed by Indians and Chinese (Table 6.14).

Table 6.14
Ethnic distribution and ethnic-specific incidence rate of melioidosis cases^, 2017

	Male	Female	Total	%	Incidence rate per 100,000 population*
Singapore residents					
Chinese	23	2	25	52.1	0.8
Malay	8	0	8	16.7	1.5
Indian	5	0	5	10.4	1.4
Others	2	0	2	4.1	1.6
Foreigners	8	0	8	16.7	0.5
Total	**46**	**2**	**48**	**100**	**0.9**

^ Excluded four foreigners seeking medical treatment in Singapore.
*Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 6.15
Total number of notifications* received for melioidosis cases, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Local	Imported	Local	Imported	Local	Imported	Local	Imported	Local	Imported
0-4	0	0	0	0	0	0	0	0	0	0
5-9	1	0	0	0	0	0	0	0	0	0
10-14	1	2	2	0	1	0	1	0	1	0
15-24	1	0	2	0	3	0	2	0	2	0
25-34	1	1	2	0	1	0	1	0	2	0
35-44	4	0	8	1	3	1	7	0	3	0
45-54	7	0	8	0	9	2	9	0	13	0
55-64	8	2	2	0	11	1	18	2	7	1
65+	5	0	8	0	9	0	15	1	19	0
Total	**28**	**5**	**32**	**1**	**37**	**4**	**53**	**3**	**47**	**1**

*Excluded tourists and foreigners seeking medical treatment in Singapore.

Burkholderia pseudomallei were isolated from blood cultures in 24 cases (Table 6.16).

Table 6.16
Types of laboratory sample of melioidosis cases^, 2017

Types of laboratory sample	No. of cases	%
Blood	24	50
Bronchial alveolar lavage	4	8.3
Endotracheal tube aspirate	1	2.1
Pleural Fluid	1	2.1
Pus	4	8.3
Sputum	1	2.1
Swabs	5	10.4
Urine	2	4.2
Others	6	12.5
Total	**48**	**100**

^ Excluded four foreigners seeking medical treatment in Singapore.

The predominant signs and symptoms of melioidosis were fever, and cough (Table 6.17). 29.2% of the cases presented with localised or multiple abscesses. Those who presented with bacteraemia comprised 70.8% of the cases in 2017 (Table 6.18).

Table 6.17
Clinical presentation of reported melioidosis cases^, 2017*

Clinical presentation	No. of cases (n=48)
Fever (with/without chills and rigors)	35
Respiratory symptoms	
Cough (productive and non-productive)	17
Runny nose	0
Chest pain	4
Other signs and symptoms	
Abdominal pain/discomfort/epigastric pain	4
Vomiting	6
Diarrhoea	5
Abscesses (localised, systemic)	14

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

Table 6.18
Cases of melioidosis presenting with bacteraemia and abscesses, 2013 – 2017

Year	Cases	Bacteraemia		Abscesses			
		No.	(%)	All Abscesses		Cutaneous	
				No.	(%)	No.	(%)
2013	34	14	41.2	20	58.8	6	17.6
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

^ Excluded four foreigners seeking medical treatment in Singapore.

27 (56.3%) of the cases had known risk factors for melioidosis (Table 6.19). One melioidosis-related death was reported in 2017.

Table 6.19
Number of cases with known risk factors for melioidosis^, 2017*

Risk factors	No of cases
Diabetes mellitus	27
Chronic lung disease (e.g. asthma, chronic obstructive pulmonary disease)	4
Chronic renal disease (e.g. chronic renal failure, kidney disease)	7

*Cases may have one or more concurrent medical conditions.
^ Excluded four foreigners 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 tuberculous 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).

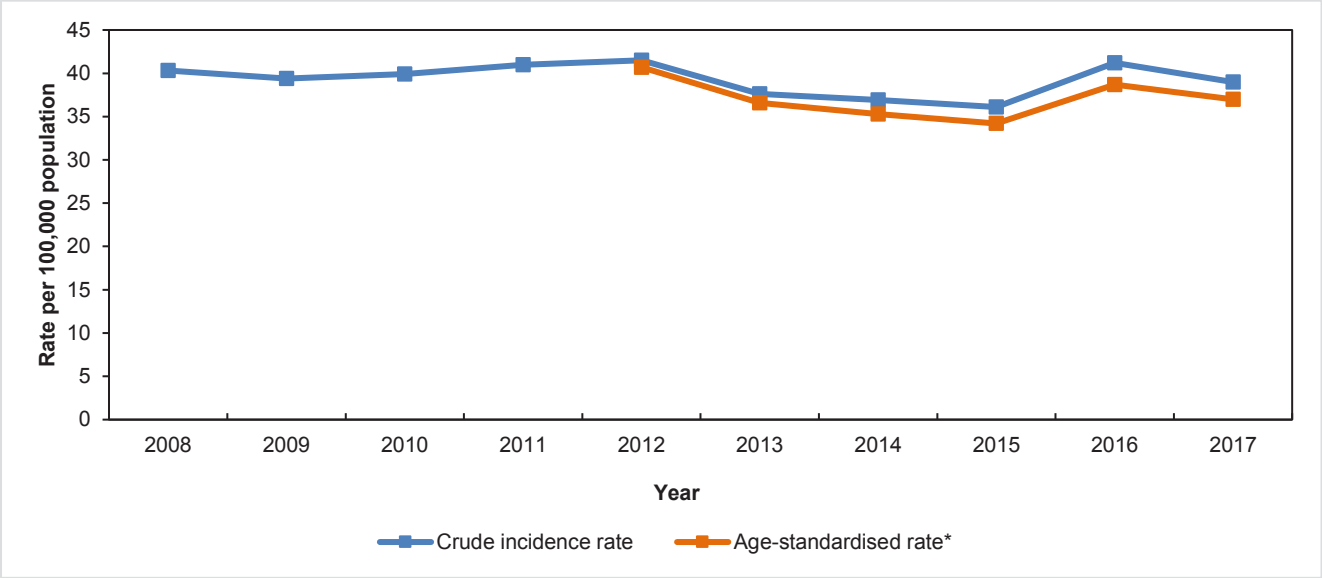
Incidence and site of disease in total population (Singapore residents, long-staying foreigners)

A total of 3,159 cases of TB were notified in 2017. This comprised 1,536 new and 124 relapsed cases among Singapore residents (citizens and PRs) and 1,451 new and 48 relapsed cases among non-residents (long-and short-staying foreigners)

A total of 2,191 new cases of TB were notified among Singapore residents and long-staying foreigners in 2017. The crude incidence rate of TB was 39 per 100,000 population in 2017 (Figure 6.3), while the age-standardised incidence rate of TB was 37.0 per 100,000 population in 2017.

The majority (85.4%) of cases had pulmonary TB with or without extra-pulmonary involvement, while the remainder (14.6%) had exclusively extra-pulmonary TB (Table 6.20).

Figure 6.3
TB incidence rate in Singapore residents and long-staying foreigners, 2008-2017



*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, 2008-2017

Year	New cases			Incidence rate per 100,000 population		
	Pulmonary[1]	Extra-pulmonary	Total	Pulmonary[1]	Extra-pulmonary	Total
2008	1,611	340	1,951	33.3	7.0	40.3
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

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

In 2017, among the 1,871 new pulmonary TB cases in Singapore residents and long-staying foreigners, 1,823 (97.4%) had bacteriological tests done. The proportion found to have demonstrable bacillary disease was 62.0% (Table 6.21)

Table 6.21
Bacillary status of new pulmonary TB cases in Singapore residents and long-staying foreigners, 2008-2017

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	1,544	95.8	1,177	76.2	24.3
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

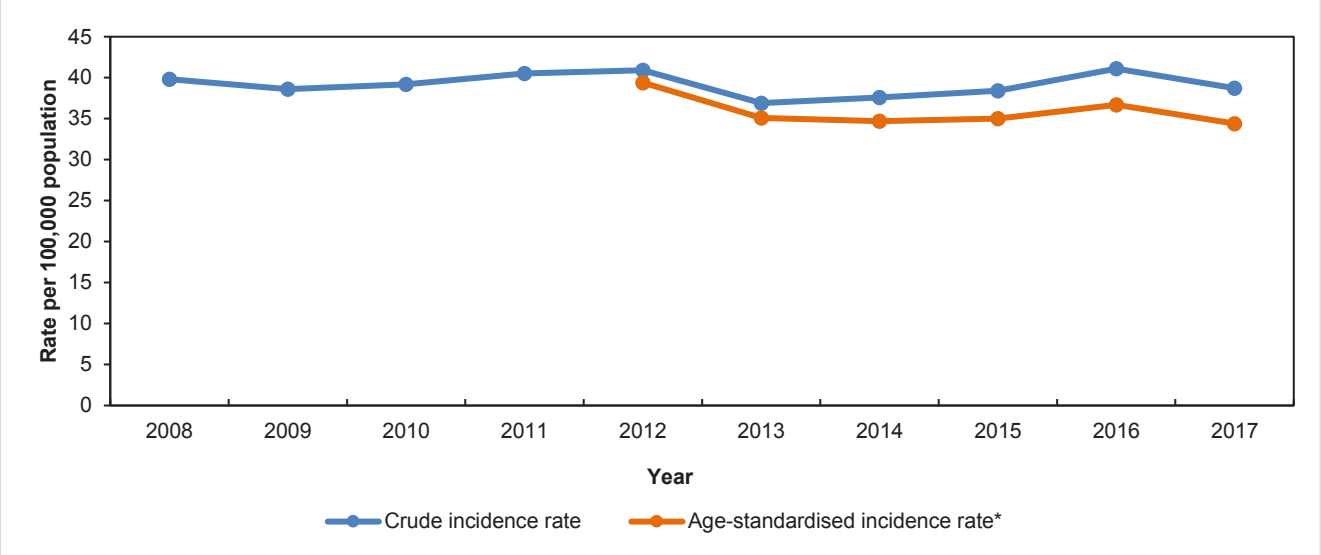
The table included only bacteriological investigations (smear and/or culture) done from three months before to two weeks after the date of notification or date of starting treatment, whichever earlier.

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 2017, the crude incidence rate of TB was 38.7 per 100,000 population. In contrast, the age-standardised incidence rate of TB was 34.4 per 100,000 population in 2017 (Figure 6.4).

Of the 1,536 new TB cases among Singapore residents notified in 2017, 1,302 (84.8%) of cases had pulmonary TB while 234 (15.2%) had exclusively extra-pulmonary TB. Of those with pulmonary TB, 181 (13.9%) had extra-pulmonary involvement while 1,121 (86.1%) did not have extra-pulmonary involvement (Table 6.22). Among cases with extra-pulmonary TB disease (415), the most common site of extra-pulmonary TB was the pleura (143), followed by the lymphatic system (114) in 2017.

Figure 6.4
TB incidence rate in Singapore residents, 2008-2017



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, 2008-2017

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

[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 1,536 new cases notified in 2017, 1,026 (66.8%) were 50 years old and above, and 1,048 (68.2%) were males. The TB incidence rate among males decreased from 55.2 per 100,000 population in 2016 to 53.9 per 100,000 population in 2017, while that among females decreased from 27.5 per 100,000 population in 2016 to 24.1 per 100,000 population in 2017.

Table 6.23
Age-gender distribution and incidence rate of TB in Singapore residents, 2017

Age group	Male	Female	Total	%	Incidence rate per 100,000 population*		
					Male	Female	Total
0-4	2	1	3	0.2	2.1	1.1	1.6
5-9	0	2	2	0.1	0	2.0	1.0
10-14	1	2	3	0.2	1.0	2.0	1.5
15-19	16	14	30	2.0	13.4	12.3	12.9
20-29	47	69	116	7.6	17.1	25.1	21.1
30-39	66	63	129	8.4	24.0	20.6	22.2
40-49	156	71	227	14.8	52.2	22.5	36.9
50-59	247	83	330	21.5	80.3	27.1	53.7
60-69	267	83	350	22.8	116.1	35.1	75.0
70-79	153	59	212	13.8	157.8	51.5	100.3
80+	93	41	134	8.7	242.6	65.1	132.3
Total	**1,048**	**488**	**1,536**	**100.0**	**53.9**	**24.1**	**38.7**

* Rates are based on 2017 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 increased from 57.6 per 100,000 population in 2016 to 64.3 per 100,000 population in 2017.The incidence rate among Chinese and Indians decreased from 39.2 and 31.9 per 100,000 population in 2016, to 34.5 and 28.7 per 100,000 population respectively in 2017 (Table 6.24).

Table 6.24
Ethnic-gender distribution and ethnic-specific incidence rate of TB in Singapore residents, 2017

Ethnic group	Male	Female	Total	%	Incidence rate per 100,000 population
Chinese	721	295	1,016	66.1	34.5
Malay	219	122	341	22.2	64.3
Indian	71	32	103	6.7	28.7
Others	37	39	76	5.0	59.4
Total	**1,048**	**488**	**1,536**	**100.0**	**38.7**

* Rates are based on 2017 estimated mid-year population.
(Source: Singapore Department of Statistics).

Clinical presentation and bacteriological status

In 2017, 1,277 (98.1%) of the 1,302 new pulmonary TB cases in Singapore residents had bacteriological tests done. The proportion found to have demonstrable bacillary disease was 68.8% (Table 6.25).

Table 6.25
Bacillary status of new pulmonary TB cases in Singapore residents, 2008-2017

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

Relapsed TB cases

In 2017, there were 124 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, 2013-2017

Age group	2013		2014		2015		2016		2017	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-9	0	0	0	0	0	0	0	0	0	0
10-19	0	3	1	0	0	0	0	0	1	1
20-29	0	2	3	0	0	3	0	3	1	3
30-39	5	3	5	7	3	2	3	5	2	2
40-49	12	3	10	3	7	6	8	3	8	6
50-59	20	2	22	5	30	9	16	8	21	2
60- 69	20	5	29	7	18	7	38	8	34	8
70+	37	7	35	10	53	6	42	8	32	3
Sub Total	**94**	**25**	**105**	**32**	**111**	**33**	**107**	**35**	**99**	**25**
Total	**119**		**137**		**144**		**142**		**124**	

TB cases in Singapore residents by country of birth

Of the 1,536 new cases notified among residents in 2017, 1,203 (78.3%) were Singapore-born and 333 (21.7%) were foreign-born. Of the 124 relapsed TB cases notified among residents, 109 (87.9%) were Singapore-born and 15 (12.1%) were foreign-born. (Table 6.27).

Table 6.27
Distribution of TB cases by age group and country of birth in Singapore residents, 2016-2017

Age group	New cases				Relapsed cases			
	2016		2017		2016		2017	
	S'pore born	Foreign born	S'pore born	Foreign born	S'pore born	Foreign born	S'pore born	Foreign born
0-9	10	2	4	1	0	0	0	0
10-19	24	4	26	7	0	0	2	0
20-29	107	20	85	31	1	2	4	0
30-39	88	47	75	54	3	5	3	1
40-49	145	56	167	60	8	3	12	2
50-59	325	41	277	53	23	1	22	1
60- 69	329	45	310	40	43	3	39	3
70+	287	87	259	87	45	5	27	8
Total	**1,315**	**302**	**1,203**	**333**	**123**	**19**	**109**	**15**

TB-HIV co-infection in residents

People living with HIV (PLWHIV) 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. PLWHIV are about 26 to 31 times more likely to develop TB disease than those who are HIV-negative worldwide. According to the 2017 WHO Global TB Report[1], people living with HIV accounted for 1.0 million (10%) of all new TB cases worldwide in 2016.

In 2017, there was a total of 1,660 notified cases of TB (both new and relapsed cases) among Singapore residents. Of these, 87.9% (1,459 cases) had a documented HIV status[2].

The prevalence of TB-HIV co-infection among TB cases with a documented HIV status was 2.1% (30 cases) of which 18 were diagnosed to be HIV positive within three months of TB diagnosis. The prevalence of TB-HIV co-infection

[1] Global tuberculosis report 2017, WHO. Pg 224
[2] This refers to the proportion of notified TB cases who were previously documented to be HIV-positive before TB diagnosis or had undergone HIV testing in the three months after TB diagnosis to detect TB-HIV co-infection.

among the new and relapsed TB cases were 2.0% (27 out of 1347 cases) and 2.7% (3 out of 112 cases) respectively. The highest TB-HIV co-infection rate among new TB cases were observed among males 50-59 years of age (Table 6.28). By ethnic group, Malays had the highest TB-HIV co-infection rate (Table 6.29).

Table 6.28
Age-gender distribution of new cases with TB-HIV co-infection in Singapore residents, 2017

Age group	New 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	1	1	3.7	0	0.4	0.2
30-39	6	0	3	22.2	2.2	0	1.0
40-49	6	1	7	25.9	2.0	0.3	1.1
50-59	11	0	12	40.7	3.6	0	1.8
60+	2	0	7	7.4	0.5	0	0.3
Total	**25**	**2**	**27**	**100**			
Age-standardised rate (per 100,00 population)					1.3	0.1	0.7
Crude Rate (per 100,00 population)					1.3	0.1	0.7

*Rates are based on 2017 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 cases with TB-HIV co-infection in Singapore residents, 2017

Ethnic group	New cases				TB-HIV co-infection rate per 100,000 population*		
	Male	Female	Total	%	Male	Female	Total
Chinese	14	0	14	51.9	1.0	0	0.5
Malay	8	2	10	37.0	3.0	0.7	1.9
Indian	2	0	2	7.4	1.1	0	0.6
Others	1	0	1	3.7	1.7	0	0.8
Total	**25**	**2**	**27**	**100**	**1.3**	**0.1**	**0.7**

*Rates are based on 2017 estimated mid-year Singapore resident population.
(Source: Singapore Department of Statistics).

TB cases in non-residents

In 2017, there were 1,451 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 26.6% (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, 2013-2017

	2013	2014	2015	2016	2017
Long-staying foreigners					
Work Permit Holders	434	409	353	473	446
Employment Pass Holder	52	27	36	44	40
Other Pass Holders*	122	128	113	176	169
Sub-total	**608**	**564**	**502**	**693**	**655**
Short-staying foreigners					
Work Permit Applicants	389	391	351	370	425
Visitors**	216	215	204	233	202
Others***	168	117	149	187	169
Sub-total	**773**	**723**	**704**	**790**	**796**
Total	**1,381**	**1,287**	**1,206**	**1,483**	**1,451**

* 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, 2008-2017

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

Table 6.32
New TB cases by site of disease in long-staying foreigners, 2008-2017

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

TB drug resistance

In this section, analyses related to TB drug resistance for Singapore residents would be presented separately amongst those who are Singapore-born and foreign-born. Cases with unknown countries of birth were excluded from the analysis. With the exception of MDR-TB cases, the data presented was based on the drug susceptibility testing (DST) result of mycobacterial cultures taken at baseline (from three months before to two weeks after the date of notification or date of starting treatment, whichever earlier). For the MDR-TB cases, the results of genotypic testing (i.e. GeneXpert MTB/Rif), which complemented the DST, were also presented.

Singapore-born residents

In 2017, drug resistance was detected in 52 (7.6%) of the 686 new pulmonary TB cases among Singapore-born residents in whom DST was performed, whereby 43 (6.3%) were resistant to one drug and 9 (1.3%) were resistant to more than one drug (Table 6.33). Isoniazid resistance was detected in 14 cases (2.0%) while MDR-TB was detected in 2 cases (0.3%).

Drug resistance was detected in 4 (6.8%) of the 59 relapsed pulmonary TB cases with DST performed, of which 2 (3.4% cases) were resistant to one drug and the other 2 cases (3.4%) were resistant to more than one drug. Isoniazid resistance was detected in 2 cases (3.4%) while there were no MDR-TB cases detected. There were no cases of extensively-drug-resistant TB (XDR-TB), i.e. MDR-TB with resistance to any fluoroquinolone and second-line injectable agent, among Singapore-born TB cases in 2017.

Table 6.33
***Mycobacterium tuberculosis* drug susceptibility in Singapore-born residents with pulmonary TB, 2014-2017**

Sensitivity result of sputum examination*	2014		2015		2016		2017	
	No.	%	No.	%	No.	%	No.	%
New cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin & Ethambutol	661	92.7	680	93.1	733	94.7	634	92.4
Resistant to:								
Single drug	38	5.3	43	5.9	34	4.4	43	6.3
More than 1 drug	14	2.0	7	1.0	7	0.9	9	1.3
Total	**713**	**100**	**730**	**100**	**774**	**100**	**686**	**100**
****Resistant to Isoniazid**	24	3.4	24	3.3	19	2.4	14	2.0
*****Phenotypic MDR**	#6	0.8	5	0.7	3	0.4	2	0.3
******Genotypic MDR**	0	0	1	0.1	0	0	0	0
Total MDR	**6**	**0.8**	**6**	**0.8**	**3**	**0.4**	**2**	**0.3**
Relapsed cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin & Ethambutol	54	88.5	61	89.7	64	88.9	55	93.2
Resistant to:								
Single drug	5	8.2	6	8.8	7	9.7	2	3.4
More than 1 drug	2	3.3	1	1.5	1	1.4	2	3.4
Total	**61**	**100**	**68**	**100**	**72**	**100**	**59**	**100**
****Resistant to Isoniazid**	6	9.8	5	7.4	6	8.3	2	3.4
*****Phenotypic MDR**	0	0	0	0	0	0	0	0
******Genotypic MDR**	0	0	0	0	0	0	0	0
Total MDR	**0**	**0**	**0**	**0**	**0**	**0**	**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.
Includes a 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.

Foreign-born residents

In 2017, drug resistance was detected in 14 (8.6%) of the 163 new pulmonary TB cases among foreign-born residents in whom DST was performed, whereby nine (5.5%) were resistant to one drug and five (3.1%) were resistant to more than one drug (Table 6.34). Isoniazid resistance was detected in eight cases (4.9%) while MDR-TB was detected in three cases (1.8%).

Drug resistance was detected in one (11.1%) of the nine relapsed pulmonary TB cases with DST performed, and it was a MDR-TB case.

Table 6.34
***Mycobacterium tuberculosis* drug susceptibility in foreign-born residents with pulmonary TB, 2014-2017**

Sensitivity result of sputum examination *	2014		2015		2016		2017	
	No.	%	No.	%	No.	%	No.	%
New cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin & Ethambutol	116	91.3	125	89.3	138	92.6	149	91.4
Resistant to:								
Single drug	8	6.3	12	8.6	11	7.4	9	5.5
More than 1 drug	3	2.4	3	2.1	0	0	5	3.1
Total	**127**	**100**	**140**	**100**	**149**	**100**	**163**	**100**
****Resistant to Isoniazid**	2	1.5	9	6.4	7	4.7	8	4.9
*****Phenotypic MDR**	1	0.8	0	0	0	0	3	1.8
******Genotypic MDR**	0	0	0	0	0	0	0	0
Total MDR	**1**	**0.8**	**0**	**0**	**0**	**0**	**3**	**1.8**
Relapsed cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin & Ethambutol	8	88.9	6	85.7	8	88.9	8	88.9
Resistant to:								
Single drug	1	11.1	1	14.3	0	0	0	0
More than 1 drug	0	0	0	0	1	11.1	1	11.1
Total	**9**	**100**	**7**	**100**	**9**	**100**	**9**	**100**
****Resistant to Isoniazid**	0	0	1	14.3	1	11.1	0	0
*****Phenotypic MDR**	0	0	0	0	0	0	1	11.1
******Genotypic MDR**	0	0	0	0	0	0	0	0
Total MDR	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**11.1**

* 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.

Non-residents

In 2017, drug resistance was detected in 64 (15.3%) of the 419 new pulmonary TB cases among non-residents in whom DST was performed, whereby 42 (10.0%) were resistant to one drug and 22 (5.3%) were resistant to more than one drug (Table 6.36). Isoniazid resistance was detected in 27 cases (6.4%) while MDR-TB was detected in 17 cases (4.1%).

Drug resistance was detected in 2 (15.4%) of the 13 relapsed pulmonary TB cases with DST performed, both of which were MDR-TB cases.

Table 6.35
***Mycobacterium tuberculosis* drug susceptibility in non-residents with pulmonary TB, 2014-2017**

Sensitivity result of sputum examination*	2014		2015		2016		2017	
	No.	%	No.	%	No.	%	No.	%
New cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin & Ethambutol	294	86.7	287	86.5	383	83.8	355	84.7
Resistant to:								
Single drug	23	6.8	32	9.6	49	10.7	42	10.0
More than 1 drug	22	6.5	13	3.9	25	5.5	22	5.3
Total	**339**	**100**	**332**	**100**	**457**	**100**	**419**	**100**
****Resistant to Isoniazid**	24	7.1	27	8.1	33	7.2	27	6.4
*****Phenotypic MDR**	10	2.9	6	1.8	18	3.9	14#	3.3
******Genotypic MDR**	1	0.3	0	0	0	0	3	0.7
Total MDR	**11**	**3.2**	**6**	**1.8**	**18**	**3.9**	**17**	**4.1**
Relapsed cases								
Sensitive to:								
Streptomycin, Isoniazid, Rifampicin & Ethambutol	11	64.7	11	68.8	4	50.0	11	84.6
Resistant to:								
Single drug	4	23.5	1	6.2	1	12.5	0	0
More than 1 drug	2	11.8	4	25.0	3	37.5	2	15.4
Total	**17**	**100**	**16**	**100**	**8**	**100**	**13**	**100**
****Resistant to Isoniazid**	3	17.6	3	18.8	1	12.5	0	0
*****Phenotypic MDR**	1¶	5.9	2	12.5	2	25.0	2	15.4
******Genotypic MDR**	0	0	0	0	0	0	0	0
Total MDR	**1**	**5.9**	**2**	**12.5**	**2**	**25.0**	**2**	**15.4**

* 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.
¶ MDR-TB resistant to both fluoroquinolone and second-line injectable.
# 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.
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 2017, there were 25 deaths from TB among Singapore residents, giving a mortality rate of 0.6 case per 100,000 population (Table 6.36). The majority were males (88.0%) and those aged 70 years and above (52.0%).

Table 6.36
Age-gender distribution and age-specific mortality rate of TB, 2017

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	4.0	0.2
30–39	0	0	0	0	0
40–49	1	0	1	4.0	0.2
50–59	4	0	4	16.0	0.7
60–69	6	0	6	24.0	1.3
70+	11	2	13	52.0	4.2
Total	**22**	**3**	**25**	**100**	**0.6**

* Rates are based on 2017 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 newly 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 timely dissemination of advice on perspectives that extend beyond individual hospitals. Table 6.37 lists the triggers and guiding criteria for reporting clusters of HAIs to the Ministry.

In 2017, a total of 44 healthcare-associated outbreaks were reported by the hospitals and institution-based care facilities (Table 6.38). Of these, respiratory outbreaks accounted for the largest proportion, with 850 cases (82.6 %) (Table 6.39).

Table 6.37
Guiding criteria for reporting of 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 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, 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). Request for 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 6.38
Number of reported outbreaks in hospitals and institution-based care facilities, 2017

Type of institution	No. of outbreaks
Hospitals (private and public)	9
Community Hospitals	2
Institution-based care facilities	33
Total	44

Table 6.39
Healthcare associated outbreaks by disease condition, 2017

Institution type/ Disease Condition	No. of incidents	Total No. of cases (range)
Hospital (9)		
Respiratory	1	27
Gastrointestinal	1	42
Skin	0	0
Multi-drug resistant organisms (MDRO)	3	13 (3-7)
Others	4 (chickenpox, conjunctivitis)	27 (1-14)
Community Hospitals (2)		
Respiratory	2	10 (2&8)
Gastrointestinal	0	0
Skin	0	0
MDRO	0	0
Others	0	0
Institution-based care facilities (33)		
Respiratory	27	850 (8-86)
Gastrointestinal	4	48 (4-48)
Skin	0	0
MDRO	0	0
Others	2 (chickenpox)	12 (4&8)

Concurrent influenza A and rhinovirus/ enterovirus outbreaks in three Long Term Care Facilities (LTCFs) at Buangkok campus, Singapore, May 2017

Outbreaks of respiratory pathogens are common in long-term care facilities (LTCFs) as the elements for transmission of infection such as infectious agents, susceptible residents and conducive environment for easy spread are all present. Such outbreaks often lead to a substantial morbidity and mortality and are also disruptive and costly.

Influenza and rhinovirus/ enterovirus are common respiratory viruses which are transmitted from one person to another through respiratory droplets during coughing, sneezing or speaking, or via contaminated surfaces. These viruses are commonly implicated in respiratory outbreaks in LTCFs. Surveillance of infectious diseases, infection prevention and control programmes and established outbreak response measures are the key factors for the prevention and control of infectious diseases outbreaks.

On 17 May 2017, MOH was alerted by LTCF A of 21 cases with fever and/ or respiratory symptoms among its residents. While investigations were ongoing, a public acute hospital within the same regional healthcare cluster informed MOH that nine residents from LTCF B were admitted to their hospital and had tested positive for influenza A on 19 May 2017.

Epidemiological investigations were immediately conducted by the HCE team to determine the extent of the outbreak, source of infection, and mode of transmission, and a field visit to six LTCFs in Buangkok campus was conducted on 22 May. A case was defined as any resident or staff who had a fever and two or more of the respiratory symptoms (i.e. cough, runny nose, sore throat, breathlessness) with an onset date on or after 29 Apr 2017 (8 days prior to the onset date of the first case on 7 May). Subsequently, LTCF C reported the 3rd respiratory cluster affecting 13 residents on 24 May 2017.

A total of 138 cases (128 residents and 10 staff) of respiratory illness with onset dates from 7 to 26 May 2017 were reported from the three LTCFs and the activity centre. The highest number of cases and the highest attack rate were observed at LTCF B where 74 cases were affected with an attack rate of 34.6%. LTCF A and LTCF C reported 38 cases with an attack rate of 22.1%, and 22 cases with an attack rate of 9.9% respectively. The highest proportion of cases was observed among residents aged 60-69 years (34.3%), followed by those between 50-59 years old (29.9%). Among the three major ethnic groups, Chinese residents (53%) had the highest proportion of cases. The most common clinical presentation amongst the cases were fever (74.6%), cough (55.1%) and runny nose (52.9%). Of the 138 cases, 10 cases were hospitalised and later discharged well. The remaining cases sought outpatient treatment. The influenza vaccination coverage amongst the resident-cases range from 70% to 96%; and amongst staff-cases range from 0% to 92%.

A total of 34 specimens were collected for respiratory multiplex Polymerase Chain Reaction (PCR) Film Essay. Further analysis was conducted on the positive influenza A isolates via whole genome sequencing (WGS) at the National Public Health laboratory (NPHL). A total of 24 (70.6%) tested positive for influenza A [influenza A(H1N1)pdm2009 (20), influenza A(H3) (1), influenza A (1), influenza A subtype undetermined (2)]; seven (20.6%) tested positive for Human Rhinovirus/ Enterovirus, and one of these seven specimens also tested positive for adenovirus and parainfluenza virus 3. The remaining three (8.8%) specimens tested negative for respiratory pathogens. The 24 influenza positive specimens were from LTCF A (10), LTCF B (13) and LTCF C (1), while the seven rhinovirus/ enterovirus samples were from LTCF C. Of the 24 influenza positive cases, eight (33.3%) attended programmes at the activity centre prior to or during their respiratory illnesses.

In response to the outbreak, the affected LTCFs stepped up temperature and health checks for all well and affected residents, implemented cohort-nursing of affected residents, and enhanced their infection prevention and control measures, including frequent hand washing for both residents and staff, use of the appropriate PPE (surgical mask) for both residents and staff and stepped up environmental cleaning.

Our investigations reported concurrent outbreaks of two respiratory pathogens in the social welfare services complex in May 2017, influenza A outbreaks affecting LTCF A and LTCF B, and a rhinovirus/ enterovirus outbreak affecting LTCF C. Nevertheless, the interventions, i.e. infection control measures, to stop these two diseases transmissions were the same and the outbreaks were eventually controlled with the termination of transmission through multi-pronged infection control approach. No further new cases identified after 26 May 2017.

WGS phylogenetic analysis of positive influenza A isolates showed that the virus from one resident from LTCF A shared high sequence identity with those from LTCF A as well as LTCF B. Taken together with epidemiological findings from the review of cases' attendance at the activity centre and the epidemic curve, this suggested that the source of infection for LTCF B was from a resident-case of LTCF A that attended the workshops at the activity centre. While there were staff from the activity centre who fell ill with respiratory illness between 7 and 19 May 2017, their role in the transmission of viruses in the outbreaks could not be determined as samples were not available for testing at the time of investigations. The sources of infections for LTCF A and LTCF C remained unknown. No Pulsed Field Gel Electrophoresis (PFGE) analysis was conducted for the Rhinovirus/ Enterovirus isolates.

In view of these respiratory outbreaks, MOH together with the LTCFs' licensing authority worked to: (a) improve their protocol for the management of non-emergency cases after office hours, so that the use of emergency medical services for non-emergency conditions (transfer of residents with fever but in stable condition to the emergency department)

could be avoided, and (b) enhance influenza vaccine uptake among residents and staff of LTCFs including those from the activity centre.

This outbreak highlighted the importance of early detection through surveillance, keeping up-to-date influenza vaccination for both staff and residents of LTCFs, and implementation of a multi-pronged infection control approach. Communication and collaboration amongst LTCFs, the regional hospital, the licensing authority of LTCFs and MOH also played a key role in stopping the transmission of the diseases and managing the outbreaks.

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 which 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. The project is operational in six public hospitals with existing programmes in TTSH, NUH, SGH and KKH, and recent extensions to CGH (since 1 April 2016) and NTFGH (since 1 October 2016).

In 2017, a total of 18,089 hospitalised patients were screened by SIDPIC programme coordinators in participating hospitals, an increase of 30.9% compared to 13,820 patients screened in 2016. Of these, 461 SIDPIC cases (including six duplicate cases) that fulfilled the inclusion criteria[3] were identified, an increase of 36.0% compared to 339 cases identified in 2016. Table 6.40 shows the SIDPIC performance indicators at six implementing hospitals for 2017.

The majority of SIDPIC cases (41.5%) had illnesses with respiratory syndromes, followed by cases with neurological illnesses (18.2%) (Table 6.41). Of the 455 cases identified in 2017, 314 were found to have alternate aetiologies, including 161 with causative pathogens detected.

Where causative pathogens were identified, respiratory viruses constituted more than half (55.8%) of all pathogens identified amongst 161 SIDPIC cases, and influenza viruses and respiratory syncytial viruses were most commonly detected. The remaining 153 cases had clinical presentations that were consistent with the clinical diagnosis, e.g. auto-immune disorders. Despite extensive laboratory testing, the aetiology in 141 (31.0%) cases remained unknown. Table 6.42 lists the pathogens which may be tested for under the SIDPIC programme.

Table 6.40
SIDPIC performance indicators, 2017

Surveillance Indicators	CGH	KKH	NTFGH	NUH	SGH	TTSH	TOTAL
No. of cases screened*	2,980	816	617	4,718	873	8,085	18,089
Death	810	115	21	1,347	144	4,175	6,612
Non-death	2,170	701	596	3,371	729	3,910	11,477
No. of SIDPIC cases	**15**	**56**	**22**	**224**	**19**	**125**	**461^**
Aetiology Found	10	42	6	173	8	75	314
Unknown Aetiology	4	14	16	51	10	46	141
Co-morbidity Found	0	1	1	0	0	0	2
No. of missed cases#	**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 6 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 134 IPD cases notified to MOH in 2017; none of them fulfilled SDIPIC recruitment criteria and they were not identified as SIDPIC cases.

[3] Inclusion criteria of SIDPIC programme:
- Age 1 to 49 years.
- Previously healthy. Exclusion criteria:
  - Immunosuppression (e.g. HIV/ AIDS, cancers, and immune disorders)
  - Chronic diseases (e.g. cardiac, lung, renal and hepatic)
- Clinical presentation suggestive of infection.
- Death or critically ill cases.
- Routine testing has not identified a known cause.

Cases with suspected infectious disease, who do not fit the above criteria but are deemed by SIDPIC physicians to be of possible public health importance are also included in the programme.

Table 6.41
Distribution of SIDPIC cases based on syndrome* classification, 2017

Syndrome	Aetiology Found	Unknown Aetiology	Total	%
Cardiac	46	21	67	14.7
Gastrointestinal	22	9	31	6.8
Neurological	60	23	83	18.2
Respiratory	130	59	189	41.6
Others	16	10	26	5.7
Multisystem	40	19	59	13.0
Total	**314**	**141**	**455**	**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 6.42
SIDPIC Lab Test Panels

	Pneumonia		Encephalitis		Viral Haemorrhagic Fever
First line panel*	**Respiratory Samples** Multiplex PCR Influenza PCR H5N1 PCR SARS CoV-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 Zikavirus (Micronesia area)		**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 Sanples** 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 one of the best ways to protect infants, children and teenagers 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 eradication of TB meningitis in young children. BCG was discontinued for Mantoux non-reactors and BCG booster dose was also discontinued in July 2001.

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 catch-up to 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 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 to prevent against cervical cancer and other HPV-related diseases. HPV vaccination was then incorporated into the National Adult Immunisation Schedule (NAIS) in November 2017 to emphasise the importance of HPV vaccination for personal protection in the 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; 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) associated with the use of OPV, the ECI recommended to switch the first four doses from OPV to inactivated polio vaccine (IPV). The new five-dose schedule comprised 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 recommended 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 deaths. 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 given 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), 2017

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 toxoid 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), 2017

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 have not been previously vaccinated or lack evidence of past infection/immunity

Recommended for adults with specific medical conditions or indications

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; and (Note: notifications of diphtheria and measles immunisation are compulsory.)

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

(c) Notification of vaccinations recommended in the NAIS have been excluded from this report as the NAIS has just been introduced and notification by medical practitioners is voluntary.

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

Vaccination against TB

In 2017, BCG vaccination was completed in 33,230 infants, giving a coverage of 98.5% (Table 7.3).

Table 7.3
BCG vaccination of infants, 2008-2017

Year	Public hospitals (%)	Polyclinics	Private clinics & hospitals (%)	Total	Coverage for children at 2 years of age*
2008	14,004 (42.9)	143 (0.4)	18,513 (56.7)	32,660	99.5
2009	13,987 (42.1)	98 (0.3)	19,134 (57.6)	33,219	99.4
2010	13,926 (42.4)	84 (0.3)	18,815 (57.3)	32,825	99.5
2011	13,301 (41.7)	67 (0.2)	18,494 (58.0)	31,862	99.5
2012	12,277 (41.1)	111 (0.4)	17,460 (58.5)	29,848	99.4
2013	12,690 (41.0)	49 (0.2)	18,236 (58.9)	30,975	99.3
2014	13,108 (39.5)	43 (0.1)	20,031 (60.4)	33,182	98.6
2015	12,569 (40.5)	54 (0.2)	18,444 (59.4)	31,067	99.3
2016	14,127 (41.6)	73 (0.2)	19,729 (58.1)	33,929	99.1
2017	14,264 (42.5)	67 (0.2)	18,899 (56.9)	33,230	98.5

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

Vaccination against diphtheria, pertussis and tetanus

Infants and pre-school children

In 2017, the primary course of vaccination was completed in 32,383 children, giving a coverage of 96.0% (Table 7.4). The first booster dose was given to 30,576 children by two years of age (90.7%).

Table 7.4
Diphtheria, pertussis and tetanus vaccination of infants and pre-school children, 2008-2017

Year	Coverage for children at 2 years of age*			
	Completed primary course		1st booster dose given	
	No.	Coverage (%)	No.	Coverage (%)
2008	31,994	97.5	29,556	90.0
2009	32,603	97.6	30,998	92.8
2010	32,014	97.0	30,165	91.4
2011	30,976	96.7	29,356	91.7
2012	29,184	97.1	27,581	91.8
2013	30,274	97.1	28,650	91.8
2014	32,438	96.4	30,510	90.7
2015	30,269	96.8	28,400	90.8
2016	33,009	96.4	30,761	89.8
2017	32,383	96.0	30,576	90.7

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

School children

In 2017, the second booster dose (using Tdap) was given to 37,367 primary five students (93.5%) (Table 7.5).

Table 7.5
Diphtheria, tetanus and pertussis vaccination (Tdap) of primary five students (10-11 years of age), 2008-2017

Year	Total no. of primary 5 students	2nd booster dose given*	
		No.	Coverage (%)
2008	49,126	47,146	96.0
2009	45,498	43,240	95.0
2010	45,555	43,238	94.9
2011	49,071	45,848	93.4
2012	43,579	40,079	92.0
2013	42,901	39,217	91.4
2014	40,065	36,392	90.8
2015	39,865	36,748	92.2
2016	40,044	36,670	91.6
2017	40,590	37,945	93.5

* From 2017, coverage is inclusive of vaccinations given by private practitioners.

Vaccination against *Haemophilus influenzae* type b

In 2017, the primary course of *Haemophilus influenzae* type b (Hib) vaccination was completed in 32,327 children (95.9%). The overall coverage for children who had completed the full course of Hib vaccination (primary and booster doses) by two years of age was 90.5% (Table 7.6).

Table 7.6
Haemophilus influenzae* type b vaccination of infants and pre-school children, 2009-2017

Year	Coverage for children at 2 years of age†			
	Completed primary course		Booster dose given	
	No.	Coverage (%)	No.	Coverage (%)
2009	26,042	78.0	25,137	75.2
2010	25,886	78.4	24,587	74.5
2011	25,817	80.6	24,720	77.2
2012	24,650	82.1	23,579	78.5
2013	26,286	84.3	25,367	81.3
2014	28,796	85.6	28,267	84.0
2015	30,076	96.1	28,028	89.6
2016	32,952	96.2	30,705	89.7
2017	32,327	95.9	30,527	90.5

* 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 2017, primary polio vaccination was completed in 32,380 children, giving a coverage of 96% (Table 7.7). The first booster dose was given to 30,534 children by two years of age (90.5%).

School children

In 2017, the second booster dose was given to 39,445 primary five students (97.2%) (Table 7.8).

Table 7.7
Polio vaccination of infants, pre-school and school children, 2008-2017

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 (%)
2008	31,980	97.4	29,339	89.4	43,548	40,055	92.0
2009	32,588	97.6	30,815	92.2	43,142	39,752	92.1
2010	31,993	96.9	30,072	91.1	39,465	37,037	93.8
2011	30,963	96.7	29,271	91.4	39,886	36,714	92.1
2012	29,183	97.1	27,521	91.6	39,682	36,782	92.7
2013	30,272	97.0	28,589	91.7	40,385	37,275	92.3
2014	32,426	96.4	30,459	90.5	-	-	-
2015	30,256	96.7	28,251	90.3	-	-	-
2016	32,993	96.3	30,735	89.7	-	-	-
2017	32,380	96.0	30,534	90.5	-	-	-

* Coverage refers to vaccinations given to all Singaporean and Singapore PR children.
† Coverage by YPSD did not include vaccinations given by private practitioners.
§ 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), 2008-2017

Year	Total no. of primary 5 students	Booster dose given*	
		No.	Coverage (%)
2008	49,126	47,314	96.3
2009	45,498	43,895	96.5
2010	45,555	44,286	97.2
2011	49,071	47,531	96.9
2012	43,579	42,091	96.6
2013	42,901	41,661	97.1
2014	40,065	38,819	96.9
2015	39,865	38,663	97.0
2016	40,004	38,815	97.0
2017	40,590	39,445	97.2

* From 2017, coverage is inclusive of vaccinations given by private practitioners.

Vaccination against measles, mumps and rubella

Pre-school children

In 2017, the first dose of measles, mumps and rubella vaccination was completed in 32,177 children (95.4%) (Table 7.9). The second dose was given to 30,342 children by two years of age (90%).

Table 7.9
Measles, mumps and rubella vaccination of pre-school and primary school children, 2008-2017

Year	Coverage for children at 2 years of age*				Primary school children†	
	Dose 1		Dose 2§		Dose 2§	
	No.	Coverage (%)	No.	Coverage (%)	No.	Coverage (%)
2008	31,315	95.4	-	-	40,342	93.0
2009	32,105	96.1	-	-	39,852	92.4
2010	31,335	94.9	-	-	36,979	93.7
2011	30,557	95.4	-	-	36,548	91.6
2012	28,652	95.4	-	-	36,341	91.6
2013	29,807	95.6	26,622	85.3	-	-
2014	32,063	95.3	29,060	86.4	-	-
2015	29,786	95.2	27,796	88.9	-	-
2016	32,406	94.6	30,126	88.0	-	-
2017	32,177	95.4	30,342	90.0	-	-

* Coverage refers to vaccinations given to all Singaporean and Singapore PR children.
† Coverage among all students in respective cohorts [11-12 years of age (primary six) up to 2007, 6-7 years of age (primary one) from 2008 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 was administered at 15-18 months of age (reported from 2013).

Vaccination against hepatitis B

In 2017, the three-dose primary course of hepatitis B vaccination was completed in 32,392 children. The overall coverage of children who had completed the primary course of vaccination by two years of age remained high at 96% (Table 7.10).

Table 7.10
Hepatitis B vaccination of infants, 2008-2017

Year	Coverage for children at 2 years of age who completed primary course*	
	No.	Coverage (%)
2008	31,910	97.2
2009	32,446	97.1
2010	31,854	96.5
2011	30,837	96.3
2012	29,134	97.0
2013	30,192	96.8
2014	32,371	96.2
2015	30,209	96.6
2016	32,913	96.1
2017	32,392	96.0

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

Vaccination against pneumococcal disease

In 2017, the two-dose primary course of pneumococcal vaccination was completed in 29,345 children, giving a coverage of 87% (Table 7.11). The booster dose was given to 27,489 children by two years of age (81.5%).

Table 7.11
Pneumococcal vaccination of infants and pre-school children, 2009-2017

Year	Coverage for children at 2 years of age*			
	Completed two-dose primary course†		Booster (3rd) dose given	
	No.	Coverage (%)	No.	Coverage (%)
2009	8,094	24.3	5,409	16.2
2010	9,810	29.7	7,161	21.7
2011	16,317	51.0	12,996	40.6
2012	19,396	64.6	15,687	52.2
2013	22,332	71.6	18,788	60.2
2014	26,303	78.2	23,043	68.5
2015	25,764	82.4	23,555	75.3
2016	28,942	84.5	26,607	77.7
2017	29,345	87.0	27,489	81.5

* 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 2017, no indigenous case of poliomyelitis or neonatal tetanus were reported. There was one indigenous diphtheria case involving a 23-year-old Bangladeshi national who worked as a construction worker in Singapore (refer to Chapter 2 for more details).

Figure 7.1
Incidence of reported poliomyelitis cases and vaccination coverage in Singapore, 1946-2017

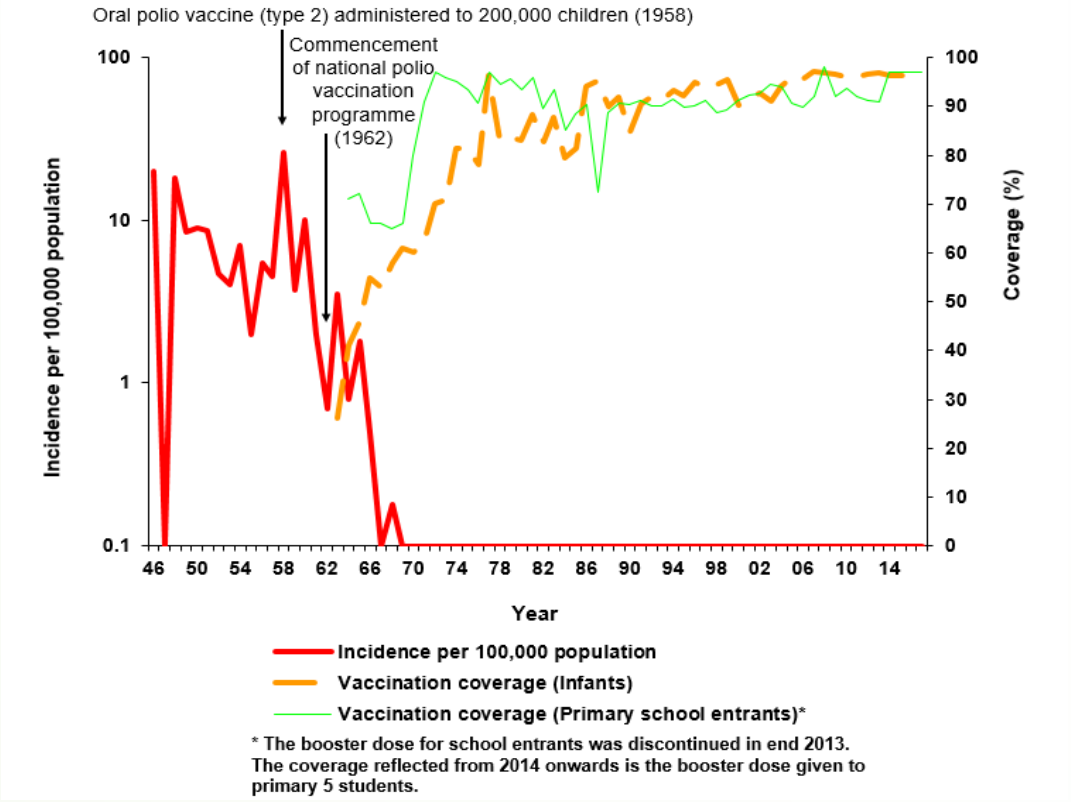
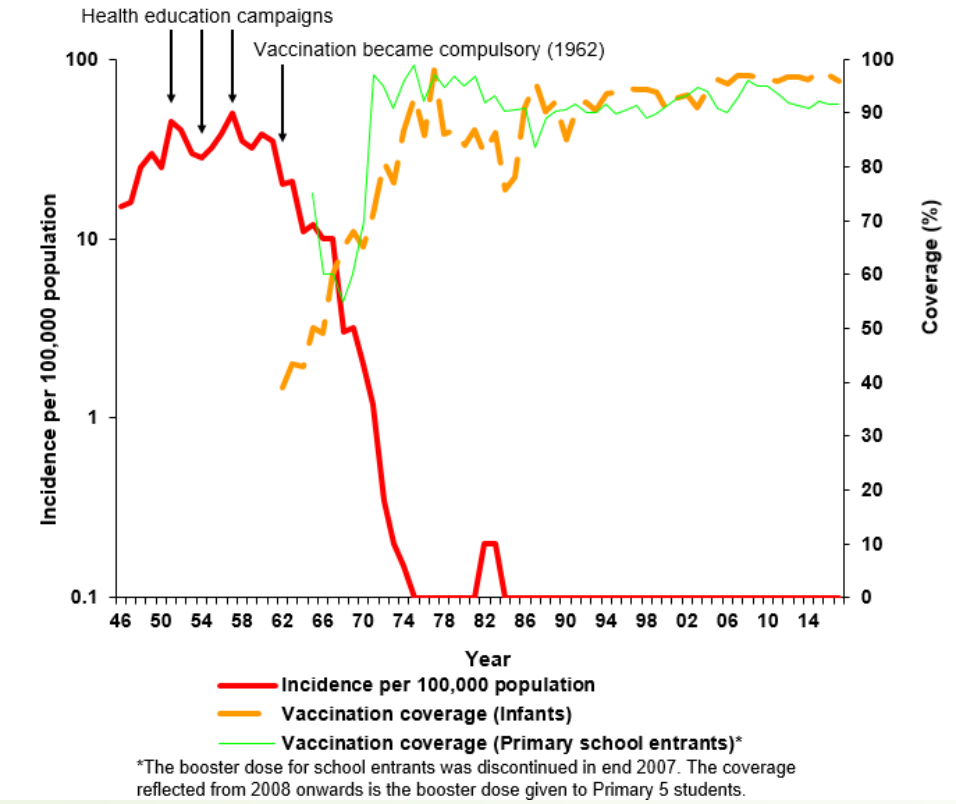
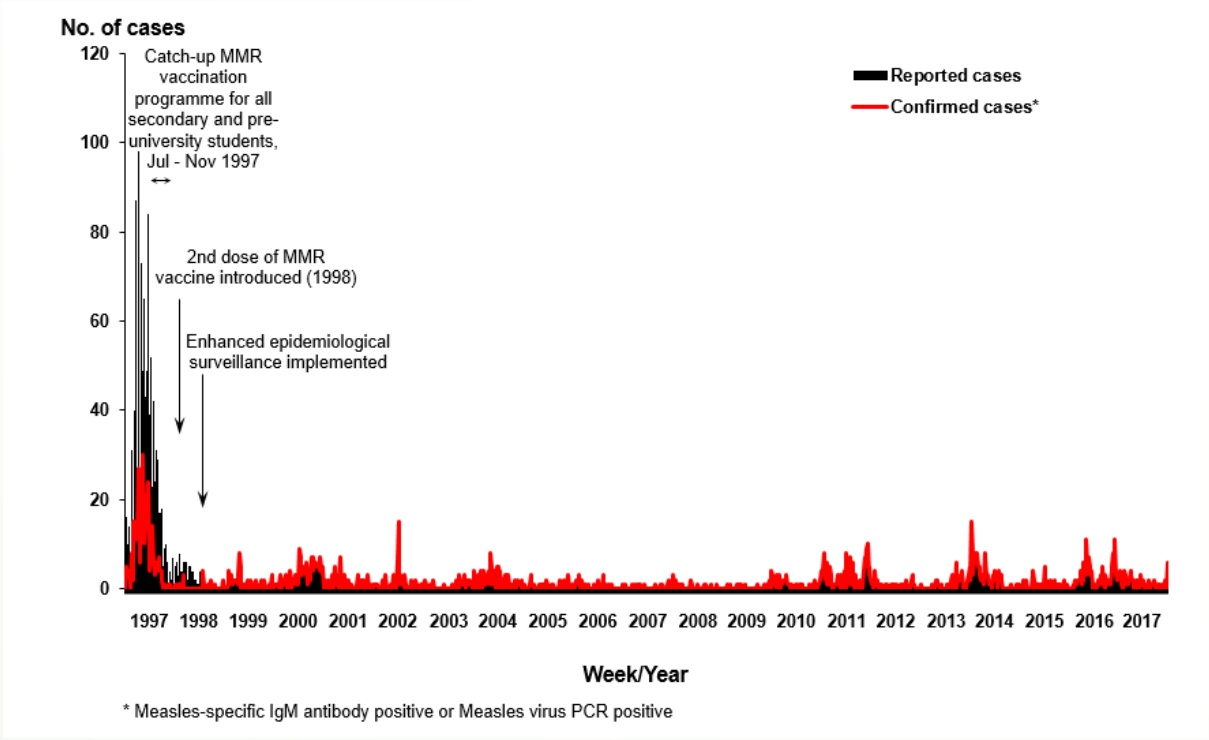


Figure 7.2
Incidence of reported diphtheria cases and vaccination coverage in Singapore, 1946-2017



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 in 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 incidence of measles decreased from 1,413 cases in 1997 to 136 in 2016 (Figure 7.3).

Figure 7.3
Impact of catch-up MMR vaccination programme and introduction of second dose of MMR vaccine on the incidence of reported measles cases in Singapore, 1997-2017



Rubella incidence decreased from 48 cases in 2013 to 15 cases in 2017. There were no reported cases of indigenous congenital rubella and two termination of pregnancy due to rubella infection was carried out in 2017 (Table 7.12).

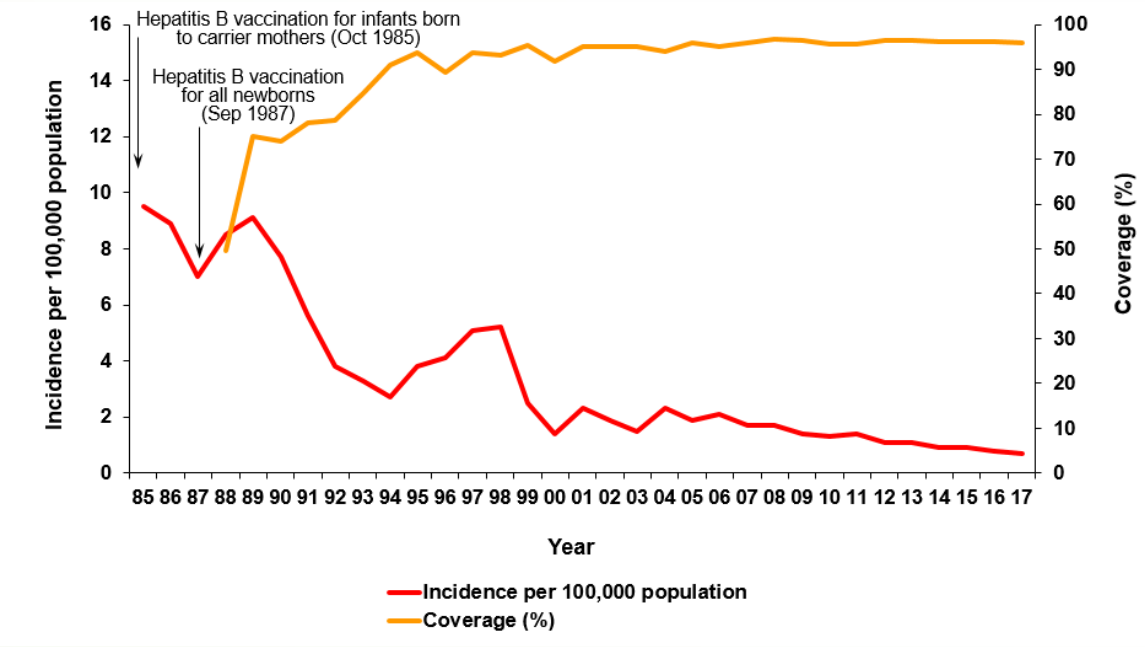
The resurgence of mumps which began in 1998, continued until the year 2002. The resurgence was due to poor protection conferred by the Rubini strain of the MMR vaccine which was subsequently de-registered in 1999. The incidence of mumps remained largely unchanged in recent years; there were 478 cases in 2014, 473 cases in 2015, 540 cases in 2016 and 524 cases in 2017 (Table 7.13).

Table 7.12
No. of therapeutic abortions performed for rubella infection, 2008-2017

Year	Total no. of abortions	No. of therapeutic abortions performed for rubella infections
2008	12,222	0
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

The incidence of acute hepatitis B cases for all age groups declined from 243 cases in 1985 to 38 cases in 2017 (Figure 7.4). During the same period, the reported number of cases in children <15 years decreased from 10 to 0 (Table 7.13).

Figure 7.4
Incidence of reported acute hepatitis B cases and vaccination coverage in Singapore, 1985-2017



A national sero-prevalence survey was conducted in 2012 to determine the prevalence of antibodies against vaccine preventable diseases and other diseases of public health importance in the adult Singapore resident population aged 18-79 years using residual sera from the National Health Survey 2010. The overall sero-prevalence was 85.0% for rubella in those aged 18-79 years. 11.1% of women aged 18-44 years remained susceptible to rubella infection. About 43.9% of Singapore residents aged 18-79 years possessed immunity against hepatitis B virus (anti-HBs ≥10 mIU/mL). The overall prevalence of HBsAg in the population was 3.6%.

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, 1988-2017

Year	Diphtheria	Poliomyelitis	Measles	Mumps*	Rubella*	Acute hepatitis B†	Neonatal tetanus‡	Pertussis§	Congenital rubella¶	Childhood tuberculous meningitis#
1988	0	0	192	-	-	2	0	11††	0	0
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

( ) 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 Singapore’s National Childhood Immunisation Schedule. This guidebook is distributed to new mothers before they are discharged from the maternity hospitals. Parents can also visit HealthHub website (at the following URL address: healthhub.sg/healthy-baby) 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.

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