Chapter VII

Childhood Immunisation

VII
CHILDHOOD IMMUNISATION

NATIONAL CHILDHOOD IMMUNISATION PROGRAMME IN 2015

The National Childhood Immunisation Programme (NCIP) in Singapore covers vaccination against tuberculosis (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.

BCG immunisation began in mid-1950s as part of the NCIP. All newborns were vaccinated at birth. Although parental consent is required, acceptance has been high and close to 100% of children has been vaccinated in the last decade (Table 7.2). The BCG immunisation programme has contributed significantly to the eradication of tuberculous meningitis in young children. BCG was discontinued for Mantoux non-reactors and BCG booster dose was also discontinued in July 2001.

Hepatitis B immunisation 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 hepatitis B immunisation programme was implemented for students in secondary 3, junior college year 2, centralised institute year 3, institutes of technical education (ITE), polytechnics and universities starting from January 2001. In addition, full-time national servicemen (NSFs) who have not been vaccinated are offered hepatitis B immunisation. The NSFs are also offered MMR and Tdap if they were not vaccinated previously.

Since January 1990, the monovalent measles vaccine given to one-year-old children was replaced by the trivalent MMR vaccine. As of January 1998, the monovalent rubella vaccine given to primary school leavers was also replaced by the second dose of MMR vaccine. The MMR immunisation was last reviewed by the Expert Committee on Immunisation in 2011 and a revised schedule was implemented in December of the same year. With the change in the immunisation schedule, both doses of MMR vaccine were brought forward to 12 months and 15-18 months respectively. School Health Services continues to provide MMR vaccine to primary one (6-7 years old) students 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 diseases 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 – 24 months of age (change to 12 months in December 2011).

The polio immunisation schedule prior to June 2013 comprised of six doses of oral polio vaccine (OPV). Inactivated polio vaccine (IPV) had been available on request and at full cost. In order to reduce the risk of vaccine-associated paralytic poliomyelitis (VAPP) due the use of OPV, the all-OPV schedule was replaced with a sequential IPV-OPV schedule. The ECI recommended a four-dose IPV schedule with three primary doses to be given at 3, 4, and 5 months of age and the first booster dose at 18 months of age. A fifth dose using OPV was recommended at 10-11 years of age (Primary 5). The OPV dose at 6-7 years of age (Primary 1) was discontinued at the end of 2013.

Haemophilus influenzae type b (Hib) immunisation was introduced into the NCIP to reduce the risk of serious complications such as meningitis and pneumonia which may lead to long-term disabilities and 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 at 18 months of age.

The ECI also recommended the use of combination vaccines containing IPV and Hib for the routine schedule. The recommendations for IPV and Hib became effective in June 2013 and the new schedule became a standard of care by January 2014. Between June and December 2013, clinics were allowed to use the existing stocks of DTaP and OPV before the replacement with IPV and Hib-containing combination vaccines.

IMPLEMENTATION OF THE IMMUNISATION PROGRAMME

The NCIP is carried out by:

(a) National Healthcare Group (NHG) polyclinics and SingHealth (SH) polyclinics
(b) Youth Preventive Services Division (YPSD), the Health Promotion Board (HPB)
(c) Private medical practitioners

Immunisation of pre-school children is carried out at the polyclinics and by private medical practitioners. The target population is based on notification of births obtained from the Registry of Births and Deaths.

Immunisation of school children is carried out by YPSD. The target population is based on student population data from the Ministry of Education.

Table 7.1
Singapore National Childhood Immunisation Schedule, 2015

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, Pertussis			**DTaP (D1)**	**DTaP (D2)**	**DTaP (D3)**				**DTaP (B1)**	**Tdap (B2)**
Poliovirus			**IPV (D1)**	**IPV (D2)**	**IPV (D3)**				**IPV (B1)**	**OPV (B2)**
Haemophilus influenzae type b			**Hib (D1)**	**Hib (D2)**	**Hib (D3)**				**Hib (B1)**	
Measles, Mumps, Rubella							**MMR (D1)**	**MMR (D2)##**		
Pneumococcal Disease			**PCV (D1)**		**PCV (D2)**		**PCV (B1)**			
Human Papillomavirus	***Recommended for <u>females 9 to 26 years</u>; three doses are required at intervals of 0, 1-2, 6 months***									

Notes:

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
MMR Measles, mumps, and rubella vaccine
Hib *Haemophilus influenzae* type b vaccine
PCV Pneumococcal conjugate vaccine
D1/D2/D3 1st dose, 2nd dose, 3rd dose
B1/B2 1st booster, 2nd booster
^ 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 15-18 months

Table 7.2
BCG immunisation of infants in Singapore in public and private sectors, 2006 – 2015

Year	Public Hospitals (%)	Polyclinics (%)	Private Clinics & Hospitals (%)	Total (%)	Coverage[1] for children at 2 years of age
2006	15,904 (41.3)	177 (0.5)	22,412 (58.2)	38,493 (100)	98.3
2007	16,399 (43.8)	205 (0.5)	20,796 (55.6)	37,400 (100)	99.4
2008	16,120 (42.1)	176 (0.5)	21,963 (57.4)	38,259 (100)	99.5
2009	15,967 (41.7)	123 (0.3)	22,228 (58.0)	38,318 (100)	99.3
2010	13,878 (42.6)	85 (0.3)	18,623 (57.2)	33,454 (100)	98.9
2011	13,123 (41.8)	67 (0.2)	18,172 (57.9)	31,362 (100)	99.6
2012	12,145 (41.2)	110 (0.4)	17,225 (58.4)	29,480 (100)	99.2
2013	15,756 (40.5)	70 (0.2)	23,076 (59.3)	38,902 (100)	99.3
2014	12,908 (39.6)	44 (0.1)	19,683 (60.3)	32,625 (100)	98.6
2015	12,460 (40.6)	54 (0.2)	18,191 (59.2)	30,705 (100)	99.6

[1] Data refer to immunisation given to all Singaporean and Singapore-PR children

Notification of immunisation

The data utilised in this report was based on:

(a) notifications of all immunisation carried out in pre-school children by healthcare institutions in both the public and private sectors to the National Immunisation Registry (NIR) at HPB. (Note: notifications of diphtheria and measles immunisation are compulsory.)

(b) immunisation records kept by YPSD (immunisations administered in schools and at the Immunisation Clinic, Student Health Centre, the Health Promotion Board).

Immunisation against diphtheria, pertussis and tetanus

Infants and pre-school children

The primary immunisation course was completed in 30,147 children in 2015 giving an estimated coverage of 97.8% (Table 7.3). The first booster dose was given to 27,666 children under two years of age (89.7%).

Table 7.3
Diphtheria, pertussis and tetanus immunisation, 2006 – 2015

	Coverage[1] for children at 2 years of age			
	Completed primary course		1st booster dose given	
Year	No.	Coverage (%)	No.	Coverage (%)
2006	31,948	95.4	30,138	90.0
2007	31,778	96.6	29,050	88.3
2008	30,975	96.9	27,888	87.3
2009	34,481	96.8	32,431	91.0
2010	32,523	96.1	30,377	89.8
2011	30,242	96.0	28,642	90.9
2012	28,776	96.7	27,196	91.4
2013	29,733	96.8	27,987	91.1
2014	31,878	96.3	29,856	90.2
2015	30,147	97.8	27,666	89.7

[1] Data refers to immunisation given to all Singaporean and Singapore PR children

School children

In 2015, the second booster dose (using Tdap) was given to 36,748 (92.2%) primary 5 students (Table 7.4)

Table 7.4
Diphtheria, tetanus and pertussis 2nd booster given to primary 5 students (10 – 11 years of age), 2008 – 2015 (Tdap)

		2nd booster dose given[#]	
Year	Total no. of primary 5 students	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

[#] Coverage by YPSD does not include booster immunisations done by private practitioners

Immunisation against *Haemophilus influenzae* type b

In 2015, the primary course of *Haemophilus influenzae* type b (Hib) immunisation was completed in 29,573 children (95.9%). The overall coverage for children who have completed the full course of Hib immunisation (primary and booster doses) at two years of age was 77.9% (Table 7.5).

Table 7.5
***Haemophilus influenzae* type b immunisation, 2009 – 2015**

	Coverage[1] for children at 2 years of age			
	Completed primary course		Booster dose given	
Year	No.	Coverage (%)	No.	Coverage (%)
2009	27,406	92.0	26,716	89.6
2010	25,524	85.6	24,126	81.0
2011	25,262	84.8	24,223	81.3
2012	24,319	81.6	23,289	78.1
2013	25,764	83.9	24,796	80.7
2014	28,221	85.3	27,675	83.6
2015	29,573	95.9	24,028	77.9

[1] Data refers to immunisation given to all Singaporean and Singapore PR children

Immunisation against poliomyelitis

Infants and pre-school children

Primary poliomyelitis immunisation was completed in 29,720 children, giving coverage of 96.4% (Table 7.6). The first booster dose was given to 27,587 children under two years of age (89.5%).

School children

In 2015, 38,663 (97.0%) primary 5 students received the second booster dose (Table 7.7).

Table 7.6
Poliomyelitis immunisation of infants, pre-school and school children, 2006 – 2015

	Coverage[1] for children at 2 years of age				School Children		
	Completed primary course		1st booster dose given		2nd booster dose given #^		
Year	No.	Coverage (%)	No.	Coverage (%)	School entrants	No.#	Coverage (%)
2006	31,935	95.4	30,009	89.7	44,572	41,312	93.0
2007	31,768	96.6	28,909	87.9	48,122	44,380	92.0
2008	30,964	96.9	27,679	86.6	43,548	40,055	92.0
2009	34,466	96.7	32,272	90.6	43,142	39,752	92.1
2010	32,496	96.0	30,299	89.5	39,465	37,037	93.8
2011	30,230	95.9	28,597	90.8	39,886	36,714	92.1
2012	28,767	96.6	27,159	91.2	39,682	36,782	92.7
2013	29,726	96.8	27,945	90.9	40,385	37,275	92.3
2014	31,878	96.3	29,768	90.0	-	-	-
2015	29,720	96.4	27,587	89.5	-	-	-

[1] Data refers to immunisation given to all Singaporean and Singapore PR children
Coverage by YPSD does not include booster immunisations done by private practitioners.
^ The OPV dose for school entrants was discontinued at the end of 2013.

Table 7.7
Poliomyelitis booster dose given to primary 5 students (10 – 11 years of age), 2008 - 2015

		Booster given#	
Year	Total no. of primary 5 students	No.	Coverage (%)
2008	49,126	47,314	96.0
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

Coverage by YPSD does not include booster immunisations done by private practitioners

Immunisation against measles, mumps and rubella

Infants and pre-school children

In 2015, a total of 29,334 children were immunised against the first dose of measles, mumps and rubella by two years of age, giving coverage of 95.1% (Table 7.8). The second dose was given to 27,243 children by two years of age (89.5%).

Table 7.8
Measles, mumps and rubella immunisation, 2006 – 2015

	Coverage[1] for children at 2 years of age				Primary school children[2]	
	Dose 1		Dose 2[3]		Dose 2[3]	
Year	No.	Coverage (%)	No.	Coverage (%)	No.	Coverage (%)
2006	31,638	94.5	-	-	48,076	95.0
2007	31,217	95.0	-	-	47,351	96.0
2008	30,352	94.9	-	-	40,342	93.0
2009	34,057	95.2	-	-	39,852	92.4
2010	32,165	95.1	-	-	36,979	93.7
2011	29,992	95.2	-	-	36,548	91.6
2012	28,320	95.1	-	-	36,341	91.6
2013	29,195	95.0	26,482	86.2	-	-
2014	31,473	95.1	29,259	88.4	-	-
2015	29,334	95.1	27,243	89.5	-	-

[1] Data refers to immunisation given to all Singaporean and Singapore PR children
[2] Coverage among all students in respective cohort (11-12 years (Primary 6) up to 2007, 6-7 years (Primary 1) from 2008 to 2011) in primary schools under Ministry of Education.
[3] Dose 2 administered at 11-12 years (Primary 6) up to 2007, 6-7 years (Primary 1) from 2008 to 2011, and 15-18 months from December 2011.

Immunisation against hepatitis B

A total of 19,892 blood samples were screened at the KK Women's and Children's Hospital for HBsAg and HBeAg in 2015. Of these, 310 (1.6%) were HBsAg positive and 84 (0.4%) were HBeAg positive.

In 2015, the primary course of hepatitis B immunisation was completed in 29,677 infants. The overall coverage for infants who completed the full course of immunisation under two years of age remained high at 96.3% (Table 7.9).

Table 7.9
Hepatitis B immunisation, 2006 – 2015

	Full course of Hepatitis B vaccination completed by age 2 years	
Year	**No.**	**Coverage (%)**
2006	31,662	94.6
2007	31,449	95.6
2008	30,924	96.8
2009	34,341	96.4
2010	32,376	95.7
2011	30,159	95.7
2012	28,730	96.5
2013	29,668	96.6
2014	31,824	96.2
2015	29,677	96.3

[1] Data refers to immunisation given to all Singaporean and Singapore PR children.

Immunisation against pneumococcal disease

In 2015, a total of 25,349 children received at least two doses of PCV by age one year, giving an estimated coverage of 82.2% (Table 7.10).

Table 7.10
Pneumococcal vaccination, 2009 – 2015

	No. completed two doses by age 1 year		No. completed booster (3rd) dose by age 2 year	
Year	**No.**	**Coverage[1] (%)**	**No.**	**Coverage[1] (%)**
2009	7,180	24.1	5,514	18.5
2010	16,930	56.8	6,906	23.2
2011	15,981	53.6	12,327	41.4
2012	18,834	61.3	15,169	50.9
2013	22,829	76.6	18,081	58.9
2014	25,955	78.2	22,824	68.8
2015	25,349	82.2	23,202	75.3

[1] Data refers to immunisation given to all Singaporean and Singapore PR children

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 2015, no indigenous case of diphtheria, poliomyelitis and neonatal tetanus was reported.

With the implementation of the '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 in 1998 and primary one school children with effect from 2008, the incidence of measles decreased from 1,413 cases in 1997 to 42 in 2015 (Figure 7.3).

Rubella incidence decreased from 48 cases in 2013 to 15 in 2015. There were no reported cases of indigenous congenital rubella and one termination of pregnancy was carried out in 2015 due to rubella infection (Table 7.11).

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 495 cases in 2013, 478 cases in 2014, and 473 cases in 2015 (Table 7.12).

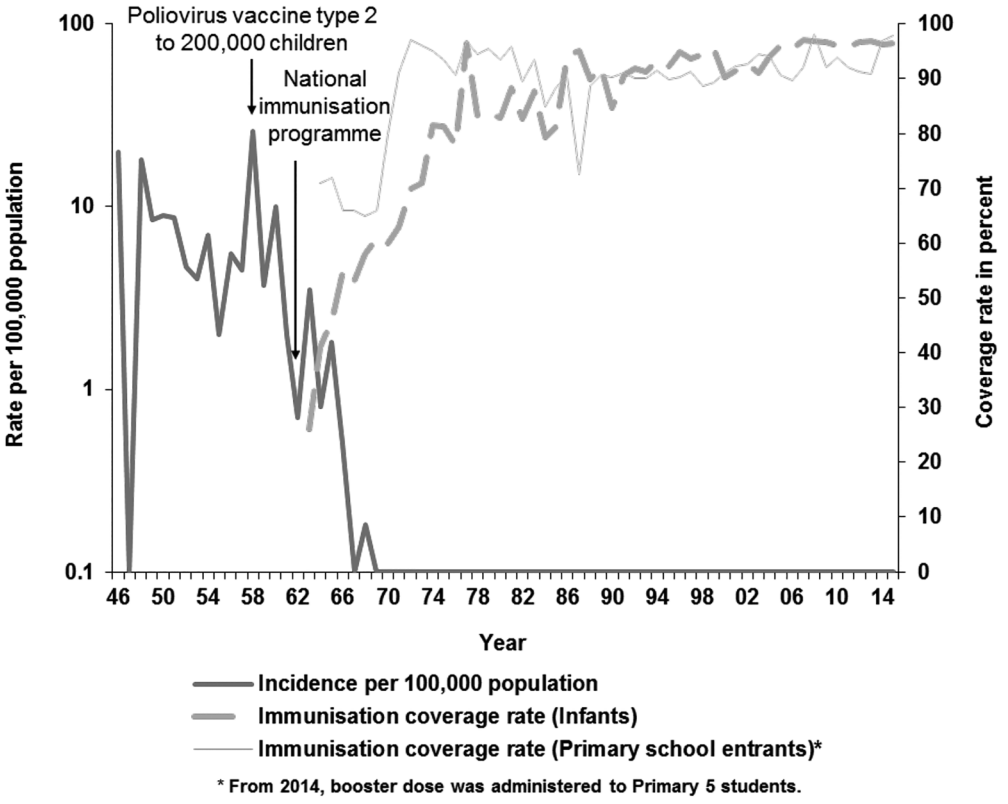
The incidence of indigenous acute hepatitis B for all age groups has declined from 243 cases (9.5 per 100,000 population) in 1985 to 52 cases (0.9 per 100,000 population) in 2015 (Figure 7.4). During the same period, the reported number of cases in children <15 years decreased from 10 to 0 (Table 7.12).

A national sero-prevalence survey was conducted in 2012 to determine the prevalence of antibody 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 18 – 44 years of age 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%.

PUBLIC EDUCATION AND PROGRAMMES

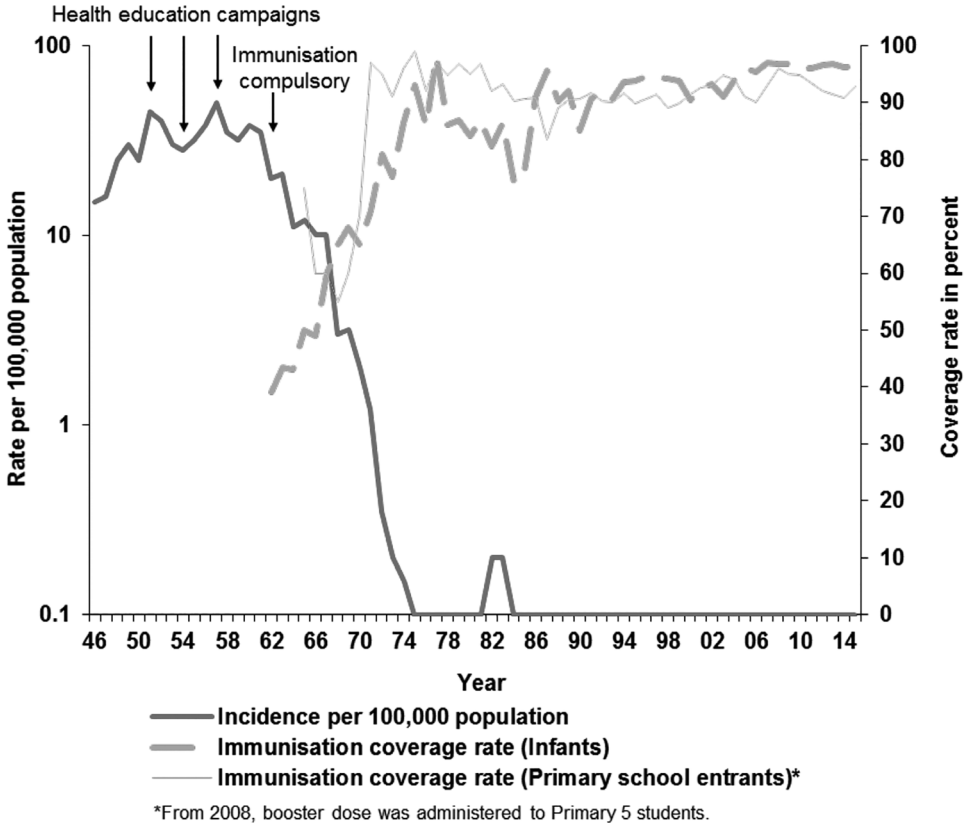
The Health Promotion Board educates parents on the importance of childhood immunisations through educational materials such as "Childhood Immunisations: Give your child the best protection" and "Protect your child against Measles, Mumps and Rubella with the MMR vaccination". These are distributed in the polyclinics and other healthcare institutions. Under the Healthier Child, Brighter Future initiative, the "Healthy start for your baby" guide also contains a chapter on childhood immunisations. This educates parents the importance of immunisation and to immunise their children according to the recommended National Childhood Immunisation Schedule. The guide is distributed to mothers who have delivered and before they are discharged from the maternity hospitals.

Figure 7.1
Incidence per 100,000 population from poliomyelitis and immunisation coverage rates in Singapore, 1946-2015



* From 2014, booster dose was administered to Primary 5 students.

Figure 7.2
Incidence per 100,000 population from diphtheria and immunisation coverage rates in Singapore,1946-2015



*From 2008, booster dose was administered to Primary 5 students.

Figure 7.3
Impact of the "catch-up" MMR vaccination programme and introduction of second dose of MMR vaccine on the incidence of reported measles cases in Singapore, 1997-2015

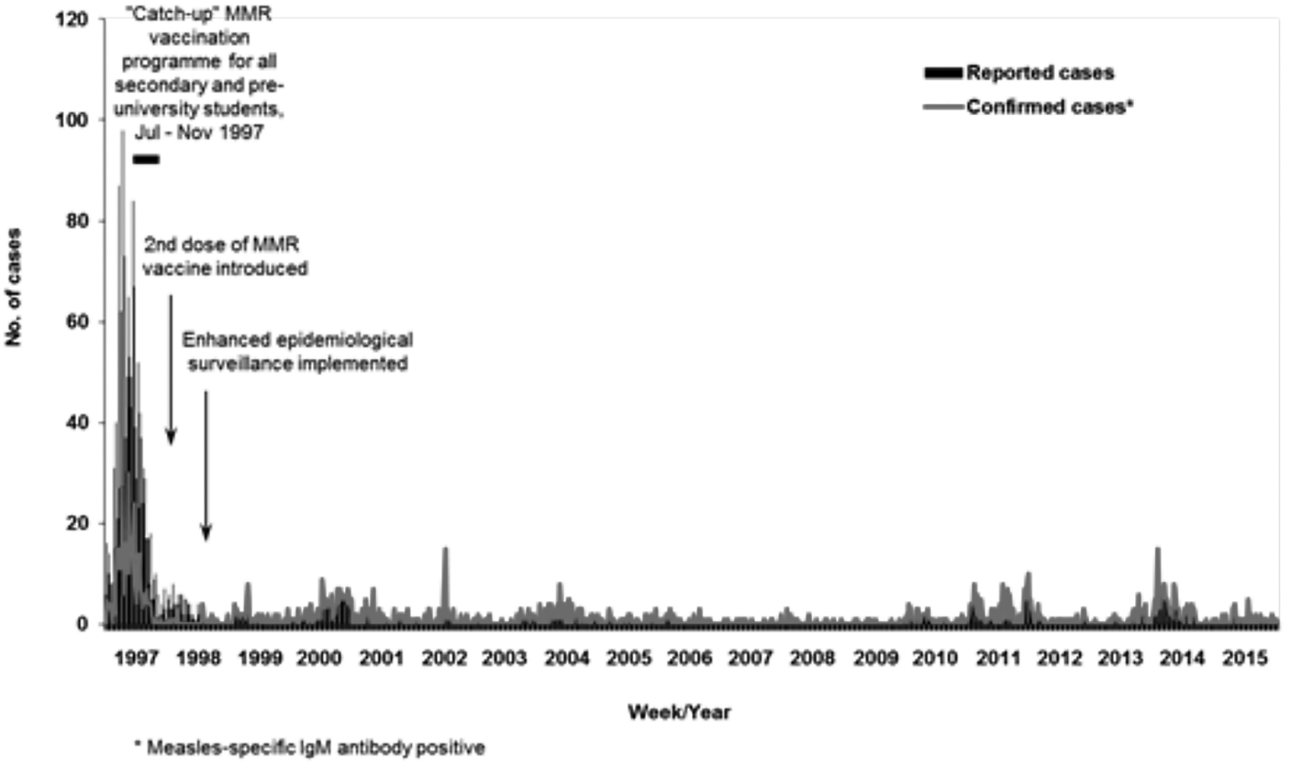
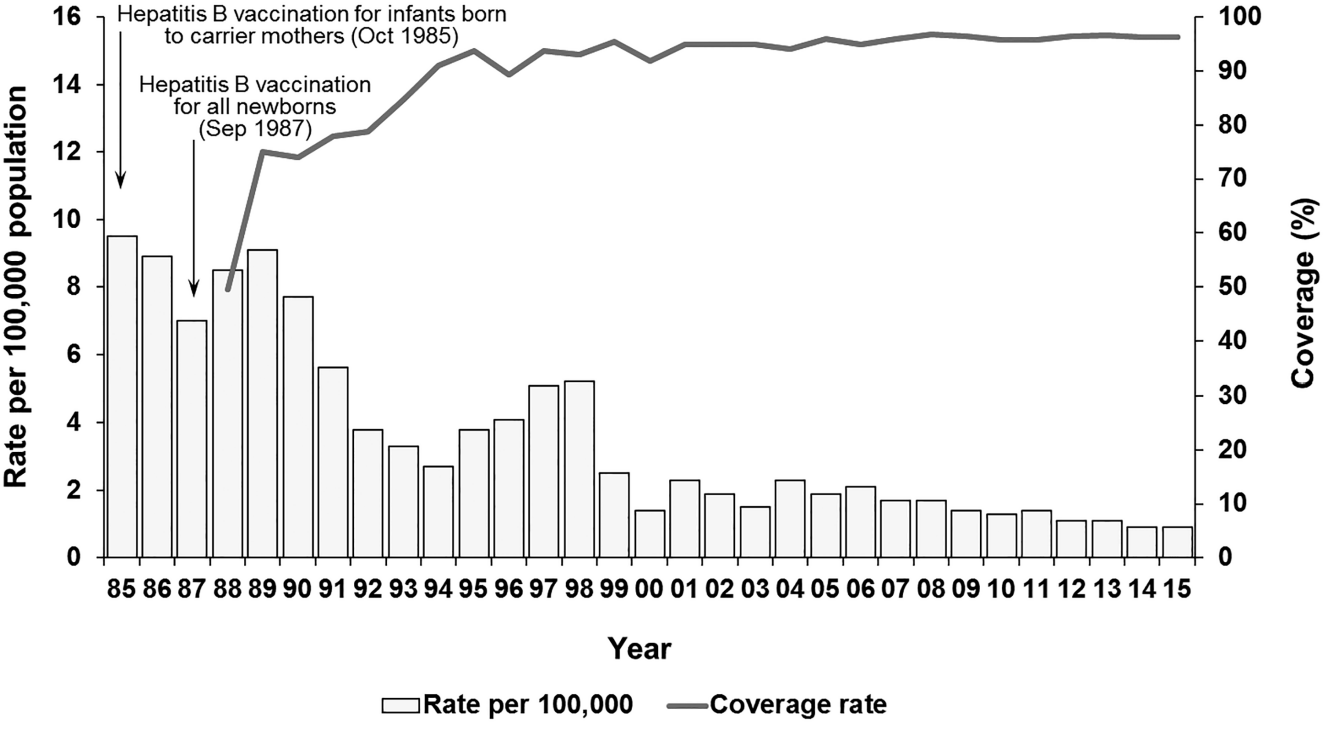


Figure 7.4
Incidence per 100,000 population from acute hepatitis B+ and immunisation coverage rates, Singapore, 1985-2015



+ Indigenous cases

Table 7.11
No. of therapeutic abortions performed for rubella infection, 2006 – 2015

Year	Total no. of abortions	No. of therapeutic abortions performed for rubella infections	
		No.	Coverage (%)
2006	12,032	3	0.02
2007	11,933	1	0.01
2008	12,222	0	0.00
2009	12,316	0	0.00
2010	12,082	0	0.00
2011	11,940	0	0.00
2012	10,624	1	0.01
2013	9,282	2	0.02
2014	8,515	0	0.00
2015	7,942	1	0.00

Table 7.12
Reported incidence of diphtheria, poliomyelitis, measles, acute hepatitis B, neonatal tetanus, pertussis, congenital rubella, and childhood tuberculosis meningitis in Singapore, 1985 – 2015

Year	Diphtheria	Poliomyelitis	Measles	Mumps*	Rubella*	Acute hepatitis B†	Neonatal tetanus‡	Pertussis§	Congenital rubella¶	Childhood tuberculous meningitis#
1985	0	0	136	-	-	7	0	0	3	1
1986	1	2(2)	218	-	-	5	3	9††	3	1
1987	1(1)	0	123	-	-	6	0	9††	2	1
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

( ) 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