NSW Health

Selected Vaccine Preventable Diseases Report | NSW 2018 - 2022

Health Protection NSW

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NSW GOVERNMENT

Health Protection NSW acknowledges the traditional owners of the lands on which we work, live and play. We pay our respect to Elders past, present and emerging. This report was produced on the lands of the Cammeraygal People of New South Wales. The knowledge, resilience and strength of Aboriginal Peoples is key to reducing the burden of vaccine-preventable diseases in their communities.

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Executive summary

This report provides an overview of the incidence of selected vaccine preventable diseases in New South Wales (NSW) for the period 2018 – 2022. It includes information on diphtheria, invasive *Haemophilus influenzae* type B (Hib), invasive meningococcal disease (IMD), invasive pneumococcal disease (IPD), measles, mumps, pertussis, rubella and tetanus. While the success of Australia's immunisation program has had a major impact on reducing the burden of these diseases over several decades, these diseases remain important causes of morbidity and mortality, particularly in at risk populations such as young children, the elderly and those with underlying chronic health conditions. This report covers the years of the COVID-19 pandemic and describes notifications by the pre-pandemic period (2018-2020), COVID-19 with restrictions (2020-2021) and COVID-19 without restrictions (2022).

The COVID-19 pandemic significantly impacted on the transmission of the viruses and bacteria responsible for these diseases in the community, predominantly due to social distancing, hygiene measures and the restriction of international travel. However, disease notifications began to return to pre-pandemic levels in 2022, highlighting the need for ongoing efforts to maintain high levels of vaccine coverage in the community, high quality surveillance and response measures and to address the socio-economic determinants of health. Importantly, the COVID-19 pandemic demonstrated that simple measures such as staying home when unwell, handwashing and being conscious of coughing and sneezing around others play a significant role in protecting the broader community from infection and disease.

Between 2018 – 2022 in NSW:

- There were nine notifications of diphtheria of which six were cutaneous disease. Despite the increasing importance of *C. ulcerans* internationally as a cause of respiratory diphtheria, only one case was reported in NSW. No cases were reported during 2020-2021.
- There were 34 notifications of invasive Hib. Hib was one of the few notifiable respiratory diseases for which incidence was similar during 2020-2021 and the pre-pandemic period. However, 2022 had the lowest number of notifications since 2012 (n = 2). Almost a quarter of notifications (24%) were for infants aged less than 1-year. One death was reported in an elderly person.
- There were 210 notifications for IMD, with 61.4% of these occurring in 2018-2019. Notifications declined during 2020-2021, likely due to COVID-19 control measures. The impact of funding of the meningococcal ACWY conjugate vaccine for young people from July 2017, and infants at 12-months of age from July 2018, likely also contributed to a decline in IMD due to W and Y serogroups. Serogroup B now dominates notifications.
- There were 2612 notifications of IPD, with the lowest number of notifications since notifications began in 2002 being reported in the 2020-2021 pandemic period (328 and 378 respectively). Across all years, notification rates were highest in children aged 0 – 4 years, adults aged 65 years and older and in those reported as Aboriginal. The five most common pneumococcal serotypes were 3, followed by 19F, 22F, 8 and 9N.
- There were 93 notifications of measles, with 66.7% of these occurring in 2019. Sixty-six (71.0%) notifications were associated with international travel or exposure to returned travellers. Forty-three (46%) cases occurred in people born between 1966 and 1994, the cohort less likely to be age-appropriately vaccinated with two doses of a measles vaccine.
- There were 219 notifications of mumps with 56.9% of these occurring in males. Only five cases were notified in 2021, the lowest since mumps became notifiable in 1991. Persons aged 15 – 64 years

accounted for 68.7% of notifications over the 5-year period. An outbreak of mumps (12 cases) occurred in 2018 in a sporting team.

- There were 14,124 notifications of pertussis with 88% of these notified prior to the pandemic. There were only 42 notifications in 2021 and 85 in 2022. Almost half (45.4%) of all notifications were for those aged 5 – 14 years of age; there were 195 cases in infants aged less than 6-months.
- There were 11 notifications of rubella with nine of these occurring in 2019. Of the cases, seven (63.6%) were in females of child-bearing age. Four females were pregnant at the time of illness; there were no notifications of congenital rubella syndrome.
- There was one notification of tetanus in an elderly person who had received a tetanus vaccine four years prior in 2015. The person survived the illness.

Table 1. Notification counts and rates per 100,000 population, selected vaccine preventable diseases, NSW, 2013 - 2022

	Diphtheria		*H. influenzae* type b		Invasive meningococcal disease		Invasive pneumococcal disease		Measles		Mumps		Pertussis		Rubella		Tetanus	
	N	Rate*	N	Rate*	N	Rate*	N	Rate*	N	Rate*	N	Rate*	N	Rate*	N	Rate*	N	Rate*
Pre COVID-19																		
2013	0	0	9	0.12	46	0.62	470	6.35	34	0.46	91	1.23	2341	31.62	12	0.16	2	0.03
2014	0	0	6	0.08	36	0.48	513	6.83	67	0.89	79	1.05	3134	41.74	9	0.12	1	0.01
2015	0	0	5	0.07	44	0.58	487	6.39	9	0.11	66	0.87	12242	160.74	7	0.09	1	0.01
2016	0	0	5	0.07	70	0.91	540	6.98	18	0.23	65	0.84	10824	139.97	7	0.09	0	0
2017	0	0	9	0.12	91	1.16	694	8.83	30	0.38	126	1.60	5267	67.05	5	0.06	1	0.01
2018	4	0.05	6	0.08	70	0.88	662	8.32	19	0.24	71	0.89	6345	79.77	0	0	0	0
2019	1	0.01	11	0.14	59	0.73	692	8.60	62	0.77	61	0.76	6333	78.70	9	0.11	1	0.01
COVID-19 with restrictions																		
2020	0	0	6	0.07	22	0.27	328	4.04	11	0.14	54	0.67	1319	16.26	1	0.01	0	0
2021	0	0	9	0.11	23	0.28	378	4.67	0	0	5	0.06	42	0.52	1	0.01	0	0
COVID-19 without restrictions																		
2022	4	0.05	2	0.02	36	0.44	552	6.76	1	0.01	27	0.33	85	1.04	0	0	0	0

* Crude rate per 100,000 population calculated with denominator as the NSW total estimated resident population for each year.

Source: Notifiable Conditions Records for Epidemiology and Surveillance, NSW Health

List of abbreviations

AIHW	Australian Institute of Health and Welfare
AIR	Australian Immunisation Register
CCLHD	Central Coast Local Health District
CI	Confidence interval
CSF	Cerebrospinal fluid
DTPa/dTpa	Diphtheria-tetanus-pertussis acellular
FWLHD	Far West Local Health District
Hib	*Haemophilus influenzae* type b
HNELHD	Hunter New England Local Health District
HPNSW	Health Protection New South Wales
HPV	Human papillomavirus
IMD	Invasive meningococcal disease (meningococcal disease)
IPD	Invasive pneumococcal disease
IPV	Inactivated polio vaccine
ISLHD	Illawarra Shoalhaven Local Health District
IQR	Inter-quartile range
LHD	Local Health District
MenB	Meningococcal serogroup B
MenC	Meningococcal serogroup C
MenACWY	Meningococcal serogroups A, C, W, Y
MLHD	Murrumbidgee Local Health District
MMR	Measles mumps rubella
MNCLHD	Mid North Coast Local Health District

NBMLHD	Nepean Blue Mountains Local Health District
NCIMS	Notifiable Conditions Information Management System
NCRES	Notifiable Conditions Records for Epidemiology and Surveillance
NIP	National Immunisation Program
NNDSS	National Notifiable Diseases Surveillance System
NNSWLHD	Northern NSW Local Health District
NSLHD	Northern Sydney Local Health District
NSW	New South Wales
PCV13	13-valent pneumococcal conjugate vaccine
PHU	Public Health Unit
PPV23	23-valent pneumococcal polysaccharide vaccine
SESLHD	South Eastern Sydney Local Health District
SNSWLHD	Southern NSW Local Health District
SWSLHD	South Western Sydney Local Health District
SYDLHD	Sydney Local Health District
VPD	Vaccine preventable diseases
WHO	World Health Organization
WNSWLHD	Western NSW Local Health District
WSLHD	Western Sydney Local Health District

Glossary of Terms

95% confidence interval (95%CI): a statistically calculated range of values that describes the uncertainty surrounding an estimate. The estimate is usually obtained from a sample of the population. The 95% confidence interval surrounding that estimate means that the "true" estimate in the entire population is likely to lie within that range 95 out of 100 times it is measured. A wide confidence interval is generally associated with a small sample and more variability.
Asymptomatic: not showing any signs or symptoms of illness or infection.
Antigen: Any substance that causes the immune system to produce antibodies against it. Foreign substances such as viruses, bacteria, chemicals, toxins and pollens are types of antigens. In some conditions, normal cell proteins in the body can also become antigens.
Booster dose (of vaccine): doses of vaccine given to 'boost' the immune system's ability to provide protection. Boosters are recommended for vaccines where protection is known to decrease over time.
Carriage: where a person is colonised (including temporarily) by an organism capable of causing disease and can spread that organism to other people.
Colonisation: organisms (e.g. bacteria or viruses) living in the body without causing illness. The body is naturally colonised by many organisms known as commensals.
Conjugate vaccine: a type of vaccine used to target bacteria that is made by chemically linking a protein molecule to polysaccharides (sugar) that makes up the cell coating of the bacterium. This improves the immune response to the vaccine, particularly in young children with immature immune systems. The protein molecules are derived from other bacteria. Conjugate vaccines used in Australia include *Haemophilus influenzae type b*, meningococcal and pneumococcal vaccines.
Enhanced surveillance: collection of extended data on notifiable conditions of importance, usually combining epidemiological, clinical and microbiological data from a range of sources. It may involve data collection from treating clinicians, reference laboratories and from the person notified.
Immunogenic/immunogenicity: the ability of a foreign substance, such as an antigen, to provoke an immune response in the body of a human or other animal.
Immunisation: the process of both getting a vaccine and becoming immune to the disease following vaccination.
Infection: when an organism which does not usually reside in the body enters the body and multiplies, causing a reaction. Infections can be asymptomatic or result in symptoms.
Live attenuated vaccine: contains a version of the living virus that has been weakened so that it does not cause serious disease in people with healthy immune systems. Live attenuated vaccines usually stimulate a strong and long-lasting immune response.
Meningitis: inflammation of the membranes surrounding the brain and spinal cord.
Monoclonal antibody: artificial proteins that act like human antibodies in the immune system.
Nasopharynx: the back of the nose and throat.
Primary course (of vaccine): the minimum number of doses of a vaccine required to provide protection.
Prophylaxis (prophylactic): prophylactic treatment is used to prevent infection, or the complications of infection, once exposed.

Reactogenicity: physical reactions that occur following vaccination and are related to the body's inflammatory response to the vaccine. Common reactions include pain and/or swelling at the injection site, fever, headache and muscle aches. The most common events are usually mild and of short duration.
Respiratory droplets: small particles of liquid produced when coughing, sneezing, or talking which can contain bacteria or virus.
Sequelae: pathological conditions which result from an infection or disease.
Sepsis: an extreme and life-threatening response of the immune system to an overwhelming infection.
Serotype or serogroup: a feature of bacteria which usually allows it to cause more severe illness. This is often a special 'capsule' or coating made up of sugars or proteins. These features can be used to tell different strains of the same bacteria apart and are usually represented by a letter or number.
Vaccination: the term used for getting a vaccine by having an injection or taking an oral vaccine dose.
Zoonoses: a disease or infection caused by an organism that is transmitted from an animal to a human.

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1. Introduction

Under the New South Wales (NSW) Public Health Act 2010,[1] certain conditions are required to be notified to public health authorities in NSW. Notification allows for a coordinated public health response to minimise the risk to the community and to limit disease transmission. Monitoring of vaccine preventable diseases (VPDs) allows an assessment of the need for, and effectiveness of, vaccine programs and can inform subsequent public health action.

This report is part of a series examining the epidemiology of notifiable VPDs in NSW. The last report for NSW was for 2017. This report covers selected VPDs notified to NSW Health for the period 2018 – 2022. It focusses on diphtheria, invasive *Haemophilus influenzae* type b disease (Hib), invasive meningococcal disease (IMD), invasive pneumococcal disease (IPD), measles, mumps, pertussis, rubella and tetanus.

Other VPDs notifiable in NSW including influenza, COVID-19, blood-borne viruses, sexually transmissible infections, enteric infections and zoonoses are reported elsewhere (Appendix 1). While varicella-zoster virus infections (chickenpox and shingles) are VPDs with vaccines available under the National Immunisation Program (NIP), they are not notifiable in NSW and publicly available data are limited to presentations to 88 NSW Health public emergency departments (Appendix 1). Poliomyelitis is notifiable, however, Australia was officially declared polio free on October 29, 2000,[2] with no locally acquired cases reported since 1972.

This report does not provide population estimates of vaccine coverage for each of the relevant vaccines. Vaccine coverage for children at 1-, 2- and 5-years of age in NSW for each of the relevant vaccines is available here: Immunisation in children by Aboriginality and age.[3]

The National Immunisation Program, 2018 – 2022

The National Immunisation Program (NIP) is funded by the Australian Government and administered by states and territories.[4] Vaccines on the NIP are free of charge if individuals meet the recommendations specific to each vaccine. Immunisation programs beyond the NIP can also be initiated and funded at a state level in response to local conditions. If recommended in the online Australian Immunisation Handbook (AIH),[5] but not eligible for free vaccine, individuals can purchase vaccines through the private sector via a prescription from their healthcare provider. The NSW Immunisation Schedule[6] is updated regularly to reflect changes to recommendations and the NIP. Detailed information about the vaccines and recommendations beyond the NIP, including contraindications, are available in the AIH.[5] Schedule changes are implemented as new vaccines become available or evidence suggests a change to the timing and type of vaccine is warranted. Changes in NSW from 2018 to 2022 relevant to this report include:

- July 2018: The combined Hib-MenC vaccines administered at 12-months of age was replaced with a single dose of quadrivalent meningococcal conjugate vaccine (MenACWY) and a dose of monovalent Hib vaccine given at 18-months of age. NSW funded a high-school MenACWY program in 2017 (Years 11 and 12), 2018 (Years 10 and 11) and in 2019 (Year 10)
- July 2018: The schedule for the 13-valent pneumococcal conjugate vaccines (PCV13) for infants without specified underlying medical conditions was amended from 6 weeks, 4- and 6-months to 6-weeks, 4- and 12-months of age. For at-risk children, the schedule remained at 6-weeks, 4-, 6- and 12-months.
- July 2018: Diphtheria-tetanus-acellular pertussis (dTpa) was funded on the NIP for all women in pregnancy (between 20 – 32 weeks gestation). NSW Health had been funding the vaccine for pregnant women from 2015.
- April 2019: 23-valent pneumococcal polysaccharide vaccine (PPV23) was funded at 4-years of age for at-risk children.
- July 2020: Meningococcal serogroup B (MenB) vaccine was funded for Aboriginal children only at 6-weeks, 4- and 12-months of age with a catch-up program for Aboriginal children less than 2-years

of age. Aboriginal children with certain at-risk conditions may require an additional dose at 6-months of age.

- July 2020. MenACWY and MenB vaccines were recommended and funded for all people with asplenia, hyposplenia, complement deficiency and treatment with eculizumab, a monoclonal antibody used to treat several auto-immune conditions.
- July 2020: PCV13 followed by PPV23 was funded for Aboriginal people aged 50-years and older and PCV13 only for people aged 70-years and older. Both PCV13 and PPV23 were funded for people with at-risk conditions for IPD.
- July 2020: Hib vaccine was funded for all people aged 5-years and older with asplenia or hyposplenia.

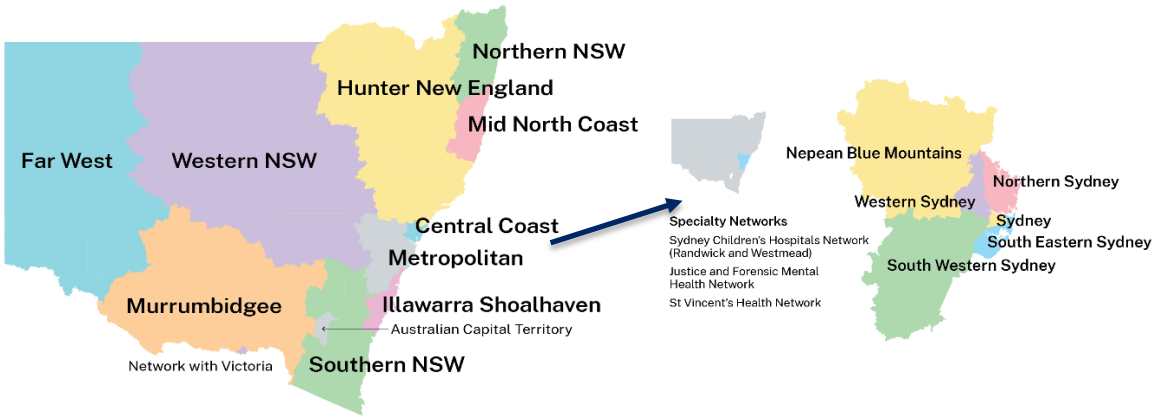
Detailed descriptions of vaccine recommendations and descriptions of relevant 'at-risk' conditions are available in the AIH[5] with the most recent version published in 2022. The National Centre for Immunisation Research and Surveillance has compiled a history of vaccines for various diseases[7] which provides detail on the introduction and changes over time in Australia for vaccines for various diseases.

2. Methods

Notification processes

Notifiable conditions are required to be notified to public health authorities in NSW under the Public Health Act 2010.[1] Public health management of notifiable conditions is carried out at the local level by 17 public health units (PHU) servicing 15 local health districts (LHD) (Figure 1) and coordinated centrally by Health Protection NSW (HPNSW). The Justice and Forensic Mental Health Network has responsibility for persons in contact with the NSW criminal justice and forensic mental health systems across the state. Most diseases are notified by laboratories following a positive test. For some high-risk diseases, cases may be notified on clinical suspicion and/or by school principals and directors of childcare facilities.

Figure 1. Map of New South Wales Local Health Districts



Enhanced surveillance

Enhanced surveillance is the process of active follow-up of cases to collect additional data to support public health policy and management decisions. This may include more detail on clinical history and outcome, vaccination status, travel history and likely place of acquisition, relevant risk factors and comorbidities and other investigations performed. Outcomes such as death are also recorded. Enhanced surveillance is generally limited to priority conditions or age-groups where the information is most useful for public health purposes (Table 1).

Table 2. Enhanced surveillance for conditions in this report

Condition	Enhanced surveillance in place
Diphtheria	All cases
Haemophilus influenzae type b	All cases
Invasive meningococcal disease	All cases
Invasive pneumococcal disease	Children less than 5-years of age Adults 50-years of age and older
Measles	All cases
Mumps	Cases for which there is no PCR result
Pertussis	Children less than 5-years of age
Rubella	All cases
Tetanus	All cases

Inclusion criteria

Notifications were included in this report if:

- They met the national surveillance case definition at time of notification for a confirmed or probable case.[8]
- The onset date was between 1 January 2013 and 31 December 2022. Onset dates were calculated as the earliest date of specimen date, report date or reported clinical onset date. The latter is usually only available for cases for which enhanced surveillance occurs.
- The residential address was in NSW. Notified cases in overseas residents that were diagnosed and managed in NSW are discussed separately where relevant.

Analyses

The source of data was the Notifiable Conditions Records for Epidemiology and Surveillance (NCRES) dataset in September 2023. NCRES is an analysis ready extract of data from the NSW Notifiable Conditions Information Management System (NCIMS), the primary repository for notifications data in NSW Health. Historical data (2008 – 2017) were included for analyses of rates over time to provide a longer period for interpretation of trends.

Notifications were analysed descriptively as counts, proportions, and rates by onset year, age, sex and Aboriginality where the information was available. Crude notification rates per 100,000 population were calculated for year of notification by age group and Aboriginality for conditions in which the completeness of Aboriginality in the dataset was high. Average annual rates are not provided given the impact of COVID-19 on the distribution of annual cases. As age-standardised rates were not calculated for this report, comparisons between Aboriginal and non-Aboriginal rates should not be made. Information on annual estimated resident population (ERP) denominator data was obtained from population estimates provided by the NSW Department of Planning and Environment which sources data from the Australian Bureau of Statistics.[9] [10] The ERPs were derived from the 2016 Census. Given changes in population size and increases in persons identifying as Aboriginal in the 2021 Census,[11] rates should be interpreted with caution.

Death data used in this report were records collected during enhanced surveillance activities or independently reported to the PHU and subsequently entered on NCIMS. Linkage to the death registration records held by the Registry of Births, Deaths and Marriages was not undertaken. Case-fatality, that is the proportion of cases with an outcome of death, were calculated when the outcome was known and only included deaths known to be due to the disease of interest.

Limitations

Notifications are known to underestimate the true incidence of disease as they depend on a person seeking healthcare if unwell, having a test performed, and that test result being reported to public health authorities. Several VPDs, particularly respiratory infections, have similar symptom profiles and, if the illness is mild, testing is less likely to occur. Cases of asymptomatic disease are rarely reported.

NSW Health preferences the use of the term 'Aboriginal' to collectively refer to Aboriginal and/or Torres Strait Islander peoples in the state,[12] in recognition of Aboriginal peoples being the original inhabitants of NSW. The completeness and accuracy of Aboriginality for cases notified by laboratories and for which no additional follow-up occurs is low as not all laboratories collect information on Aboriginality.

There will be some differences between data presented in this report and counts reported on NSW Health's Infectious Diseases A – Z data webpages[13] as A-Z excludes cases for which age-group and/or sex are unknown.

Changes in case definitions are likely to influence trends over time. Notifications prior to a change in the case definition are not adjusted retrospectively to account for the new definition. Where relevant, changes are reported in each section.

Analyses and interpretation of vaccination data from NCIMS can be complicated by changes in the schedule over time, data quality and completeness and the timing between receipt of the last dose of vaccine and disease onset. The latter is important as sufficient time post-vaccination is required to generate enough antibodies to confer protection.[14] The optimal duration for that interval will differ between vaccines. For long intervals, waning immunity may occur, particularly in older persons in whom immune function declines[15] and for vaccines for which antibody levels decline over time. Vaccination status in this report is based on data obtained directly from persons notified or from the notifying physician. This may be self-report, confirmed by a medical record or confirmed by a person reporting from their AIR or infant health record.

The accuracy of deaths data may be affected by the duration from onset of disease to time of death. For example, if the death occurred several weeks or months after initial notification, and the follow-up for that notification has been completed, it may not be reflected in NCIMS. Confirmation of a particular disease as the primary or contributing cause can be complicated and classification may be missing or unknown in NCIMS for many cases.

3. Diphtheria

Diphtheria is a potentially life-threatening infection caused by toxin-producing strains of *Corynebacteria*, which infect the upper respiratory tract (nose and throat) or the skin. Both *Corynebacterium diphtheriae* (a commensal of the human respiratory tract and skin), and *Corynebacterium ulcerans* (a commensal of animals including domestic dogs, cats, and livestock) can produce the toxin which causes diphtheria.

C. diphtheriae can be spread from person to person, including asymptomatically. Conclusive person-to-person transmission of *C. ulcerans* has not been documented. Infection with *C. ulcerans* usually occurs following contact with animals, or ingestion of unpasteurised animal milk products.

Toxigenic *Corynebacteria* infection of the respiratory tract (respiratory diphtheria) can lead to the formation of a membrane in the back of the throat which makes it hard to breathe and swallow. Swelling of the lymph glands in the neck may also result in a characteristic 'bull neck'. Both *C. diphtheriae* and *C. ulcerans* can cause respiratory diphtheria.[16] Infection of the skin (cutaneous diphtheria) can result in large non-healing ulcers, often starting as smaller lesions. These occur most commonly on the legs. In a small number of cases the toxin may also enter the blood stream and result in damage to the heart (myocarditis) and nerves (neuropathy), which can be fatal.

The advent of a diphtheria toxoid vaccine in 1923 and widespread increases in coverage of the 3-dose series of diphtheria, tetanus and pertussis (DTP) containing vaccines in the early 1970s led to diphtheria becoming rare in countries with high vaccine coverage.[17] However, outbreaks still occur and are often associated with displaced populations and infrastructure failures during periods of civil unrest, war and natural disasters.[17]

The vaccine

The diphtheria vaccine protects against the toxin produced by the bacterium, but not carriage.[18] Diphtheria toxoid is a component of the combined DTP vaccine and the schedule matches that of tetanus and pertussis. Infants and children receive funded DTP vaccine at 6-weeks, 4-, 6- and 18-months and at 4-years of age and in Year 7 of school. A dose of DTP vaccine is funded during pregnancy, primarily for the pertussis component. Adults aged 50-years and 65-years and older are recommended to receive DTP vaccine if their last dose was more than 10-years ago.

Epidemiology

In 2017, the national surveillance case definition for diphtheria changed, making the criteria for notifying cutaneous cases of toxigenic *C. diphtheriae* or *C. ulcerans* clearer. Confirmed cases required both laboratory definitive evidence and clinical evidence of an upper respiratory tract infection or skin lesion. Prior to 2018, the last notification of diphtheria in NSW was in 1991.

Between 2018 and 2022, nine cases of diphtheria were notified in NSW, three respiratory and six cutaneous. There were no cases notified in 2020 or 2021. There were eight cases of *C. diphtheriae* and one case of *C. ulcerans*. Case characteristics are presented in Table 3. Six of the nine cases were residents of the Northern NSW LHD. There were no deaths reported. One respiratory case had toxin-mediated sequelae requiring extended hospitalisation with potential long-term effects.

Table 3. Characteristics of diphtheria cases, NSW, 2018 - 2022

	2018	2019	2022

Total	**4**	**1**	**4**
C. diphtheriae	3	1	4
C. ulcerans	1	0	0
Age	15 – 24 years – 1 45 - 64 years – 1 65 – 74 years - 2	45 – 64 years	0 – 4 years – 1 5 – 9 years – 1 45 – 64 years - 2
Gender	Male – 2 Female - 2	Male	Male - 4
Site	Cutaneous – 3 Respiratory – 1 (*C.ulcerans*)	Cutaneous	Cutaneous – 2 Respiratory - 2
Place acquired	Overseas – 3 NSW - 1	Not reported	NSW – 2 Interstate – 1 Unknown - 1
Vaccination status	Fully - 2 Uncertain - 2	Uncertain	Fully – 1 Partially – 2 Uncertain - 1

Two cases of respiratory diphtheria occurred in partially vaccinated Aboriginal children in 2022. Infections were acquired in NSW and were genomically linked to a cluster in Northern Queensland, largely affecting Aboriginal and Torres Strait Islander people.[19] In that cluster, 76% of cases were cutaneous, 38% occurred in people fully-vaccinated for age and 48% in those partially vaccinated.[19] A 2022 cutaneous case in an adult NSW resident, acquired in QLD, was also linked to this cluster.

Comment

While diphtheria remains rare in countries with high vaccination coverage, recent cases here and internationally demonstrate disease continues to occur, predominantly in unvaccinated and vulnerable populations such as refugees.[19-21] The proportion of cases associated with *C. ulcerans* has increased in several countries over the past decade,[16 22 23] particularly among older people and in settings in which booster doses of vaccine in adults are not recommended. The decline in vaccine coverage globally associated with the COVID-19 pandemic,[24] provides further potential for increases in diphtheria cases to occur.

As the vaccine does not prevent carriage of the bacterium, and fully vaccinated people can spread the bacteria to unvaccinated contacts,[17] vaccination is critical to protecting against the toxin which causes potentially fatal disease. Immunity can wane over time depending on the number of doses received, the intervals between doses and with age,[25] thus receipt of booster doses as recommended is important.

4. *Haemophilus influenzae* type b

Haemophilus influenzae type b disease (Hib) is caused by infection with the *Haemophilus influenzae* type b bacterium. Humans are the only known reservoir, and the organism can be carried asymptomatically in the

back of the nose and throat. Hib is predominantly transmitted by direct, close contact with respiratory droplets or discharges from the nose and throat of an asymptomatic carrier. Rarely, it can be transmitted from infected persons. Hib does not survive in the environment on non-living surfaces.[26]

Hib causes both invasive and non-invasive diseases, however, invasive infections associated with sepsis, meningitis, epiglottitis and bacteraemic pneumonia are among the most serious. Even with appropriate treatment, up to 40% of children with bacterial meningitis can suffer permanent disabilities and up to 5% may die.[27] The clinical presentation can be indistinguishable from other invasive bacterial infections.

The incidence of invasive Hib in Australia and other countries with high vaccine coverage has declined by more than 90% since the introduction of the Hib vaccine, although sporadic outbreaks can still occur.[28] The declines are the result of both direct and indirect (herd immunity) effects of vaccination.

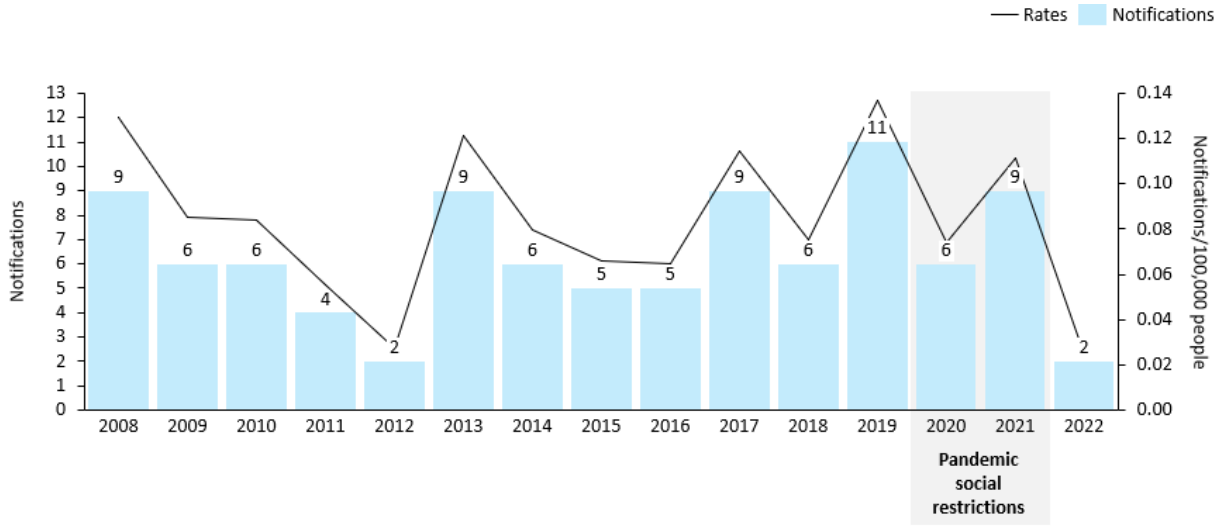
The vaccine

Hib vaccine was included on the Australian childhood immunisation schedule in 1993. The vaccines used in Australia are conjugate vaccines. The type of carrier protein used in the vaccine to improve immune responses in infants has changed over time, with the vaccines currently used in NSW conjugated to the tetanus-toxoid protein. Hib vaccine is now included in a range of combination vaccines, such as the DTPa/IPV/Hib/hepatitis B vaccine given to infants at 6-weeks, 4- and 6-months of age. Monovalent (one antigen only vaccine) Hib vaccine is used as a booster at 18-months of age. Protection following immunisation is considered long-lasting, particularly following a booster dose.[29]

Epidemiology

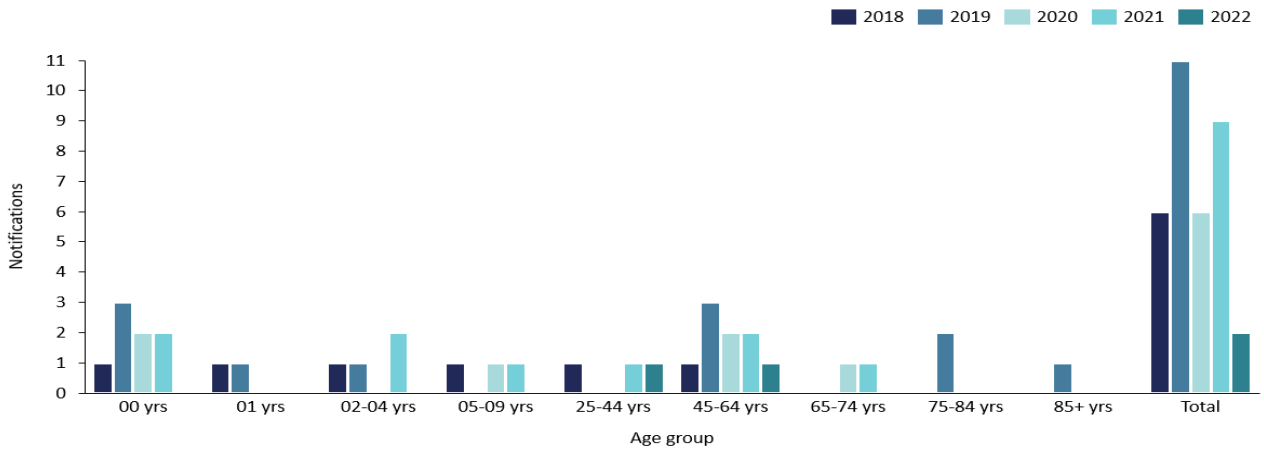
Between 2018 – 2022, 34 cases of Hib were notified in NSW, the same as for 2013 – 2017. Eleven cases were reported in 2019, the highest since 2006. While counts for 2020-2021 were similar to other years, only two cases were reported in 2022. Annual notification rates per 100,000 population from 2008 - 2022 are in Figure 2.

Figure 2. Invasive *Haemophilus influenzae* type b notifications by year, NSW, 2008 - 2022



Of the 34 cases notified during 2018-2022, 55.9% were in males and eight (24%) were in infants aged less than 1-year (Figure 3). Five cases (14.7%) were in persons reported as Aboriginal; four were infants aged less than 12-months and one was aged greater than 50-years. One death attributed to Hib was reported in a non-Aboriginal person greater than 65-years of age; outcome was unknown in one case.

Figure 3. Invasive *Haemophilus influenzae type b* notifications by age-group and year, NSW, 2018 – 2022*



*There were no cases in persons aged 10 – 24 years

Among infants aged less than 12-months (n = 8), five were reported as fully vaccinated for age, two partially vaccinated and one was unvaccinated. Among the fully vaccinated infants, one had received their last dose two days prior to disease onset, two were vaccinated 21- and 37-days prior, one 41-days prior and one 157-days prior. All cases in children aged 1 – 9 years (n = 9) were reported as fully vaccinated. Eight of the nine vaccinated children had received their last dose of Hib vaccine between 6-months to 5-years prior to disease onset; time since vaccination was missing for one case.

Comment

Hib was one of the few notifiable respiratory diseases in NSW that did not decrease during the 2020-2021 COVID-19 restrictions. This pattern was also observed elsewhere with an international analysis reporting declines of invasive disease due to all *H. influenzae* serotypes combined, except Hib, in 2020-2021.[30] The reason for the lack of decline in Hib during the pandemic is currently not well understood.

The success of Hib vaccination in early childhood means disease is now rare. In Australia and other countries with high vaccine coverage, unvaccinated young children, the elderly, people with chronic diseases, immunosuppression and asplenia and those who are socio-economically disadvantaged remain at highest risk.[28] Aboriginal children are affected disproportionately and this remains a concern.[31] Further, while not preventable by the Hib vaccine, ongoing monitoring of invasive infections due *to* other *H. influenzae* serotypes that are important contributors to disease, particularly type a (Hia) and non-typeable *H. influenzae* (NTHi), is necessary.[28]

Despite the high effectiveness of the Hib vaccine, disease can occur in vaccinated individuals. This is predominantly associated with underlying medical conditions (including prematurity) and immunoglobulin deficiencies.[32] It rarely occurs in immunologically competent children.[33]

5. Invasive meningococcal disease

Invasive meningococcal disease (IMD) is a rare and potentially fatal illness caused by infection with the *Neisseria meningitidis* bacterium. *N. meningitidis* commonly resides in the back of the nose or throat without causing illness (colonisation).[34] Rarely, transmission of the bacterium from person-to-person through close contact (such as sharing a household or intimate kissing) results in infection, rather than colonisation. IMD occurs when the bacterium causes infection in the bloodstream (meningococcaemia) or lining of the brain and enters the spinal cord which causes inflammation of the membranes surrounding the brain and spinal

cord (meningitis). Infection of the synovial fluid surrounding the joints (septic arthritis) is also a form of IMD. Death and permanent disability can occur, even with effective treatment. Up to 10-15% of invasive infections result in death, even with appropriate antibiotic therapy and up to 20% of those infected will suffer long-term complications including sight or hearing loss, neurological damage, loss of limbs or digits, and/or skin scarring.[34]

N. meningitidis is classified into serogroups based on the presence of a polysaccharide capsule, which increases their ability to cause invasive disease. Twelve meningococcal serogroups have been identified: A, B, C, E, H, I, K, L, W, X, Y and Z.[35] Globally, A, B, C, W and Y are responsible for the majority of cases.[36] In Australia, almost all IMD is caused by serogroups B, C, W and Y with serogroup B now the most common.[37]

The vaccine

There are several meningococcal vaccines available in Australia and the schedule and target groups for funded vaccine have changed over time. Some meningococcal vaccines, like the meningococcal ACWY conjugate vaccine, target the capsule(s) specific to the serogroup(s). Others, like the meningococcal B vaccines, target specific components of the bacterial membrane. Vaccination against one serogroup, does not protect against other serogroups.[38] Vaccines against MenC were funded and in use up to 2017 when it was replaced with the MenACWY vaccine. MenB was not funded under the NIP until 2020 and then only for Aboriginal and Torres Strait Islander children and people of all ages with specific high-risk conditions.[39]

Epidemiology

From 2018-2022, 210 IMD cases were notified; 33% (n = 70) occurred in 2018 (Figure 4). In 2020 and 2021, the number of IMD notifications fell to 22 and 23 respectively.

Meningococcal serogroup B (n = 128) was the dominant serogroup identified between 2018 - 2022 (Figure 4), followed by Y (n = 36), W (n = 34), not grouped (n=10) and C (n = 2). Cases due to serogroups W and Y combined accounted for a greater proportion of cases in 2018 than serogroup B (50.0% compared to 45.7% respectively). In 2022 the number of cases due to serogroup B (n = 32, 89.9%) was similar to the immediate pre-pandemic period although proportionally lower as a cause of IMD during that period (2018 n = 32 (45.7%), 2019 n = 34 (57.6%)).

Twenty-four cases (11%) were in Aboriginal people; Aboriginality was not reported in seven cases (3.3%). Notifications and notification rates per 100,000 population by Aboriginality and year are presented in Figure 5.

Figure 4. Invasive meningococcal disease notifications by serogroup and year, NSW, 2008 - 2022

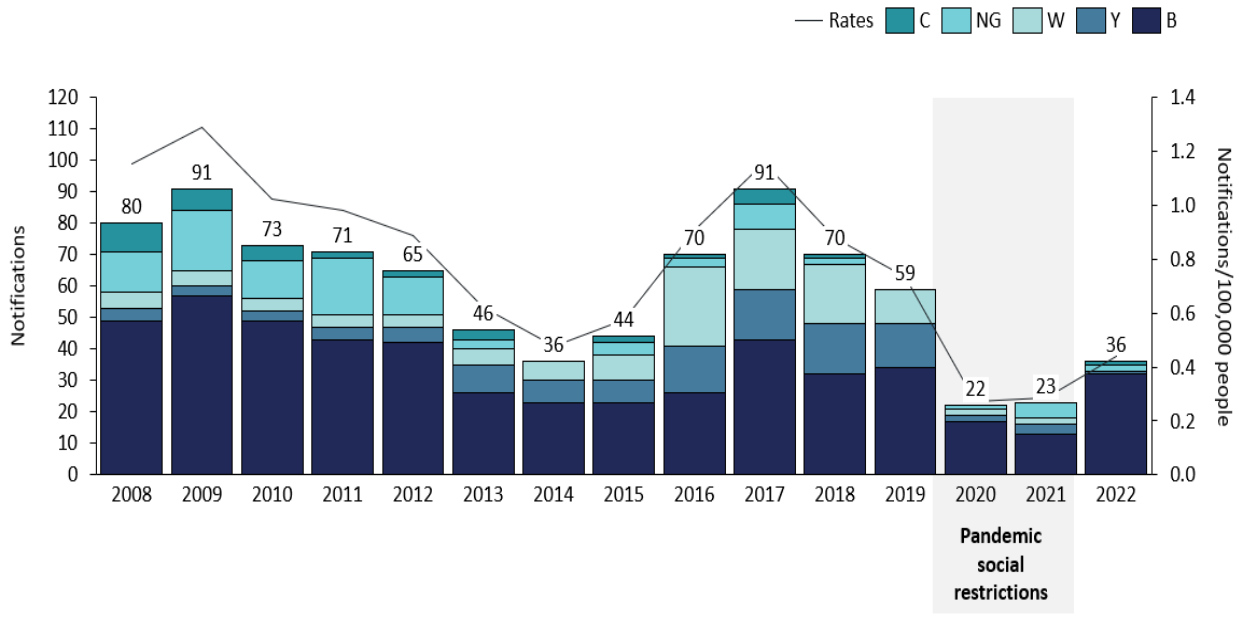
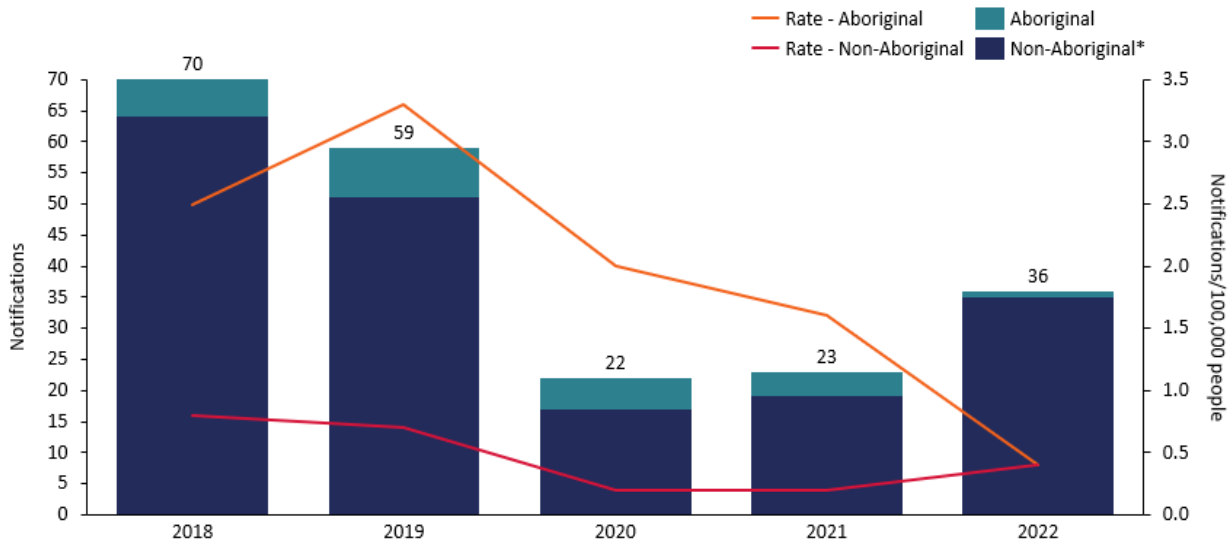


Figure 5. Invasive meningococcal disease notifications by Aboriginality*, NSW, 2018 - 2022



*Non-Aboriginal rates include cases in which Aboriginality was unknown or missing

Gender and age-group

Of the 210 notifications over the 5-year period, 111 (52.9%) were for males. People aged 15-24 years accounted for the greatest proportion of notifications (n = 60, 30%) followed by infants aged less than 12-months (n = 30, 14.3%). Notifications by age-group and year are presented in Table 4.

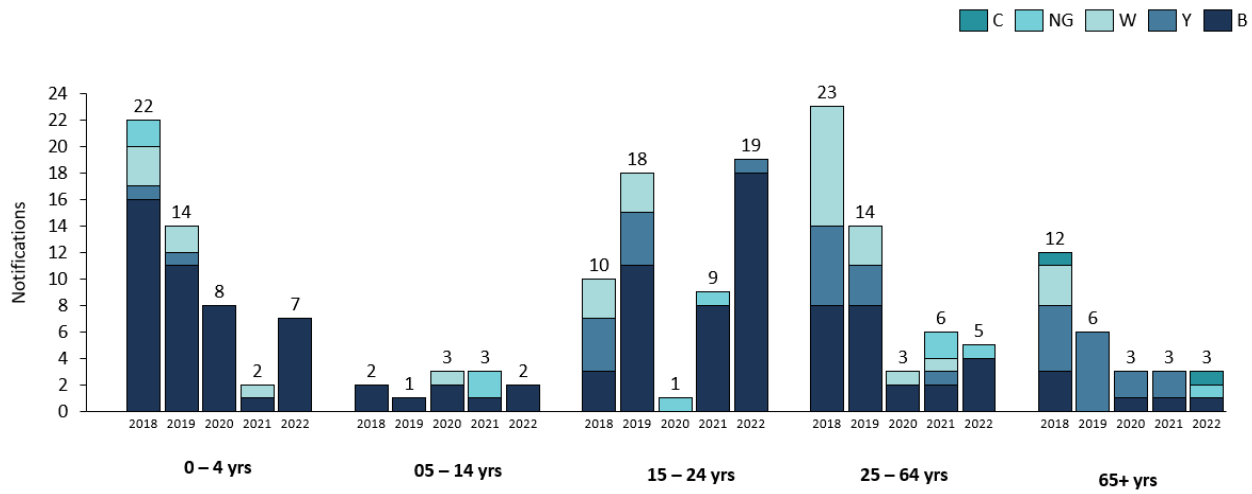
Table 4. Invasive meningococcal disease notifications by age-group and year, NSW, 2018 – 2022

Age-group (years)	2018		2019		2020		2021		2022	
	N	Rate*	N	Rate*	N	Rate*	N	Rate*	N	Rate*
0-4	22	4.1	14	2.6	8	1.5	2	0.4	7	1.3
5-9	2	0.4	1	0.2	1	0.2	1	0.2	0	0.0
10-14	0	0.0	0	0.0	2	0.4	2	0.4	2	0.4
15-19	6	1.3	12	2.6	4	0.9	7	1.5	11	2.3
20-24	4	0.9	7	1.5	1	0.2	2	0.4	8	1.6
25-29	3	0.5	2	0.4	0	0.0	1	0.2	1	0.2
30-34	2	0.3	1	0.2	0	0.0	1	0.2	1	0.2
35-39	3	0.5	0	0.0	1	0.2	0	0.0	0	0.0
40-44	1	0.2	1	0.2	0	0.0	2	0.4	2	0.4
45-49	1	0.2	1	0.2	0	0.0	0	0.0	0	0.0
50-54	3	0.6	3	0.6	1	0.2	1	0.2	1	0.2
55-59	3	0.6	3	0.6	1	0.2	1	0.2	0	0.0
60-64	7	1.6	3	0.7	0	0.0	0	0.0	0	0.0
65-69	2	0.5	3	0.7	1	0.2	0	0.0	1	0.2
70-74	5	1.5	3	0.9	1	0.3	1	0.3	1	0.3
75-79	2	0.8	2	0.8	0	0.0	0	0.0	0	0.0
80-84	3	1.8	1	0.6	1	0.6	1	0.5	0	0.0
85+	1	0.5	2	1.1	0	0.0	1	0.5	1	0.5
Total	**70**	**0.9**	**59**	**0.7**	**22**	**0.3**	**23**	**0.3**	**36**	**0.4**

* Crude notification rate per 100,000 population per year

There were 30 (14.3%) cases in infants aged less than 12 months; 22 (73%) were serogroup B, five serogroup W, two serogroup Y and one was not serogrouped. Eight infants were reported as Aboriginal, Aboriginality was unknown in two cases. Cases by age-group, serogroup and year are presented in Figure 6.

Figure 6. Invasive meningococcal disease notifications by age-group, serogroup and year, NSW, 2018 – 2022.



Site of infection

Blood was the principal site of *N. meningitidis* detection in 119 cases; brain, cerebrospinal fluid and/or

meninges in 39 cases; the joint synovium in four cases, and it was detected in more than one site in 44 cases.

Vaccination status

Of all serogroup B notifications (n = 128), three had a record of receipt of at least one dose of meningococcal B vaccine. All three were in non-Aboriginal persons aged less than 3-years, 15-19-years and 65-years and older. The child had received one dose 316-days prior to onset of disease, the young person had received 2-doses with last dose 81-days prior and the adult had received one dose 129-days prior. Of the 11 serogroup B cases notified for Aboriginal children aged less than 5-years, nine cases occurred prior to vaccine being available on the NIP. One infant was too young to have been vaccinated and the other (greater than 2-months of age) was unvaccinated.

Among the serogroup W and Y cases (n = 70), one (serogroup Y) was vaccinated with a MenACWY vaccine; a teenager who had been vaccinated 12-months prior to disease onset. Meningococcal vaccination was reported in two cases where vaccine type was unknown and vaccination status was uncertain in 17 cases. Of the unvaccinated cases (n = 50), three would have been eligible for funded vaccine prior to disease onset. Neither case of serogroup C, both aged more than 70-years, had a record of meningococcal vaccination.

Of the 10 cases of IMD not serogrouped, five were reported as fully vaccinated for age, four with MenC vaccines and one with MenACWY vaccine; one was too young to have been vaccinated, vaccination status was uncertain in one and three adults aged 30-years and older were not vaccinated.

Case fatality

Across the reporting period, 14 deaths due to IMD were notified in NSW; 50% occurred in 2018. Case-fatality amongst all cases for which outcome was known (n=210) was 6.6%. Case fatality was highest for serogroup W (4/34, 11.8%), followed by serogroup B (9/128, 7.4%) with one death reported for serogroup Y (1/35, 2.9%). There were no deaths reported for serogroup C cases or cases with no serogroup identified.

Among those who died, none of the serogroup B cases were vaccinated with a serogroup B vaccine (unknown for one case). Of these, two were Aboriginal children – one death occurred in 2019 before MenB vaccine was available on the NIP for Aboriginal children (available from July 2020); the other child was more than 5-years of age and had not been eligible for vaccine. The one serogroup Y case was unvaccinated however was aged great than 80-years at time of death. Of the four serogroup W cases, one was unvaccinated and vaccination status was unknown for the remaining three. Of these, two were not eligible for funded vaccine and one had been eligible within the 18-months prior to death.

Place of acquisition

Of the 210 cases across the reporting period, 165 were acquired in NSW, four overseas (all serogroup Y) and origin was not reported in 41 cases.

Comment

The incidence and serogroup prevalence of IMD in NSW, and globally, has varied over time and is strongly impacted by the widespread use of serogroup specific vaccines.[35] Prior to 2003 when the MenC vaccine was included in the NIP, the predominant serogroup associated with IMD was serogroup C.[40] Serogroup C represented only 1% of IMD cases (all unvaccinated) in NSW between 2018 and 2022.

Increases in IMD due to serogroup W and serogroup Y were observed in 2015 and continued through 2016 and 2017. These serogroups affected a wider range of ages, serogroup W disease tended to be more severe and had a higher CFR than other serogroups. Case fatality overall and by serogroup in NSW during 2018-2022 was consistent with a systematic review which reported lower mortality for serogroup B than other

groups.[41] Case fatality for serogroup Y in NSW (2.9%) was low compared to the 10.8% (95%CI 8.2 – 13.4%) reported in that review.[41]

In response to this change in serogroup prevalence, progressive introduction of the MenACWY vaccine occurred across Australia, beginning in 2016. Cases due to serogroups W and Y subsequently began to decline in the age-groups targeted for immunisation.

While the overall decline in IMD notifications in 2020 and 2021 is likely due in part to the impact of COVID-related social restrictions and hygiene measures, and the absence of influenza (known to increase the risk of IMD),[42] the serogroup prevalence in those years suggests the meningococcal ACWY vaccination program also had an effect. In 2022, a pandemic year without social restrictions, the reduction in serogroup variability continued despite an increase in notified cases.

6. Invasive pneumococcal disease

Invasive pneumococcal disease (IPD) is caused by the bacterium *Streptococcus pneumoniae*. *S. pneumoniae* is a common member of the bacterial flora colonising upper airways of healthy children and adults. Carriage rates vary widely across populations, and can be lower in high-income compared to low-income settings.[43] In parts of Australia, carriage is high in Aboriginal people.[44] *S. pneumoniae* causes a broad range of diseases ranging from conditions such as otitis media (middle ear infection) through to serious conditions such as sepsis leading to death. Only invasive infections are notifiable; the bacterium must be isolated from a sterile site (for example, blood or cerebrospinal fluid). IPD is usually associated with severe bacteraemic pneumonia, sepsis, meningitis and osteomyelitis. People most at risk of IPD include children under 2-years of age, older adults, Aboriginal people, people with chronic diseases, immunosuppression and asplenia/hyposplenia, and those who smoke.[45]

IPD can occur at any time of year, but typically increases in winter and during periods of high respiratory virus activity including influenza, parainfluenza, respiratory syncytial virus, and human metapneumovirus.[46] [47] During the COVID-19 pandemic period, the risk of IPD in 30 countries and territories, including Australia, was estimated to have decreased by approximately 53% compared to 2018-2019 (risk ratio 0.47; 95%CI 0.40-0.55).[30] This was considered an effect of the social restrictions imposed, hygiene measures promoted and the decline of other respiratory viruses, particularly influenza, during the pandemic.[30] Case numbers began to rise by the end of 2021.[30]

In this report, enhanced data on vaccination status and deaths is only reported for children aged less than 5-years and adults aged 50-years and older as case follow-up was routinely undertaken for these higher risk age groups.

Serotype

There are over 100 serotypes of pneumococcal bacteria. Different pneumococcal serotypes vary in their likelihood to cause disease and influence the severity of disease. Since the introduction of pneumococcal conjugate vaccines (7-, 10- and 13-valent vaccines), disease due to serotypes contained in the vaccines declined globally in regions with high vaccine coverage through both direct and indirect effects (i.e. herd immunity) of vaccination.[48] Declines in nasopharyngeal carriage of vaccine-type serotypes also occurred, however carriage of non-vaccine serotypes remains a concern.[43] [49] The residual burden due to non-vaccine serotypes remains substantial.[50] Some serotypes contained in pneumococcal vaccines are less immunogenic than others, partially explaining the persistence of certain vaccine serotypes as important causes of disease.[48] [51]

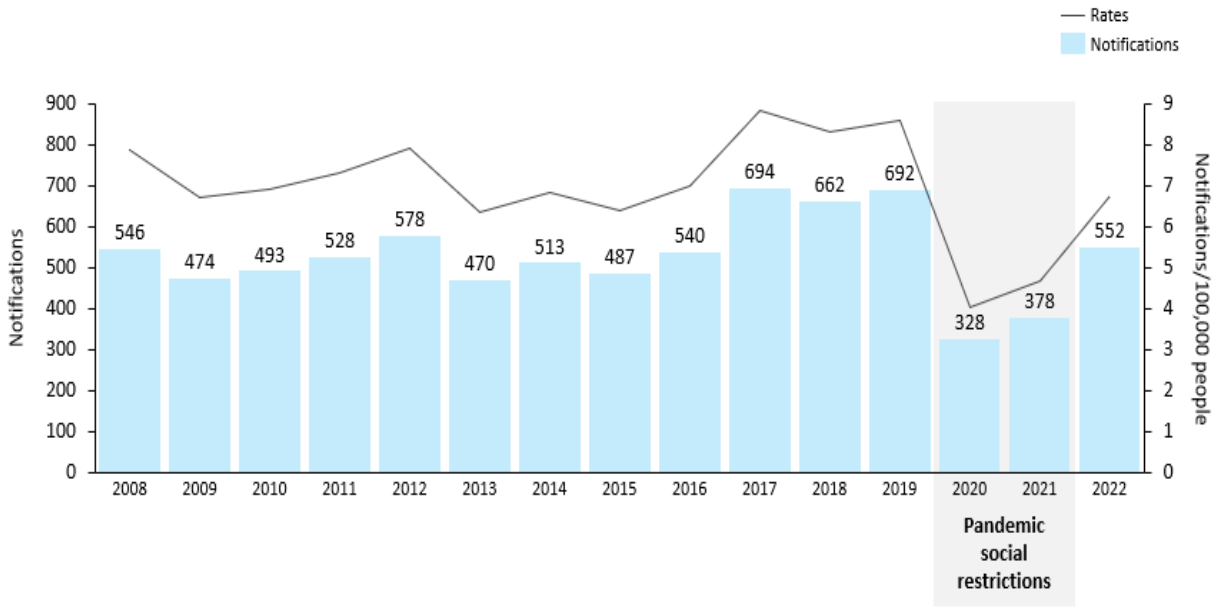
The vaccine

The pneumococcal vaccines target the serotype specific capsules of the bacteria. There are two pneumococcal vaccines in use in Australia, the 13-valent vaccine pneumococcal conjugate vaccine (PCV13) which covers the 13 serotypes that were most associated with invasive disease in young children before their introduction (1, 3, 4, 5, 6A, 6B, 7F, 9V, 14, 18C, 19A, 19F, 23F). The 23-valent pneumococcal polysaccharide vaccine (PPV23) covers 12 of the 13 serotypes in the PCV13 (1, 3, 4, 5, 6B, 7F, 9V, 14, 18C, 19A, 19F and 23F) and 11 additional serotypes (2, 8, 9N, 10A, 11A, 12F, 15B, 17F, 20, 22F,and 33F).[52] PPV23 does not induce an efficient immune response in infants and is not registered for use in children aged less than 2-years.[5] New 15 and 20 valent conjugate vaccines have recently been approved but are not yet funded under the NIP.[52]

Epidemiology

Between 2018 – 2022, 2612 cases of IPD were notified with 2020 and 2021 having the lowest number of notifications since it became notifiable in 2002.[13] Notifications returned to pre-2018 levels in 2022 (Figure 7).

Figure 7. Invasive pneumococcal disease notifications by year, NSW, 2008 – 2022.



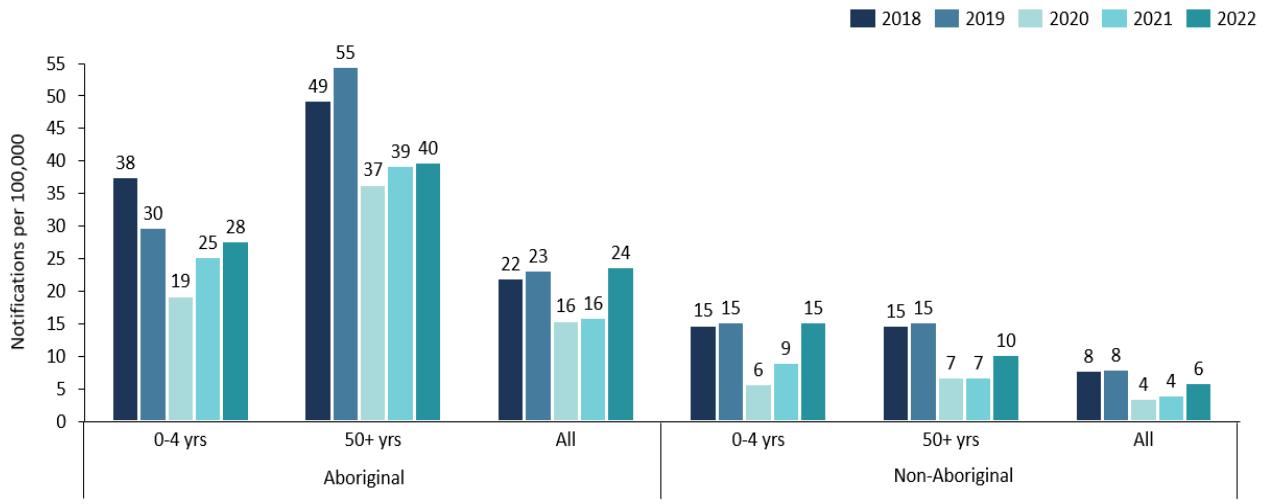
Of the 2018-2022 notifications, 1374 (52.6%) were for males and 252 (9.6%) were for Aboriginal people; Aboriginality was not reported in 166 (6.4%) notifications. Notifications and notification rates per 100,000 population by age-group and year are in Table 5. Annual notification rates per 100,000 by Aboriginality and specific age-groups are in Figure 8. Across all years, notification rates were highest in children aged 0 – 4 years, adults aged 65-years and older and in those reported as Aboriginal.

Table 5. Invasive pneumococcal disease notifications by age-group and year, NSW, 2018 – 2022.

Age-group (years)	2018		2019		2020		2021		2022	
	N	Rate*	N	Rate*	N	Rate*	N	Rate*	N	Rate*
0-4	87	16.1	88	16.1	36	6.6	55	10.0	89	16.2
5-9	18	3.6	24	4.7	7	1.3	11	2.1	18	3.4
10-14	8	1.7	5	1.0	5	1.0	4	0.8	10	2.0
15-19	6	1.3	10	2.2	1	0.2	6	1.3	7	1.4
20-24	10	2.1	11	2.3	3	0.6	8	1.6	11	2.2
25-29	16	2.9	10	1.8	7	1.3	5	0.9	10	1.8
30-34	21	3.5	16	2.7	10	1.7	7	1.2	14	2.3
35-39	31	5.5	20	3.5	13	2.2	24	4.0	16	2.6
40-44	19	3.6	28	5.3	18	3.4	22	4.1	28	5.1
45-49	23	4.3	31	5.8	17	3.2	20	3.8	26	4.9
50-54	33	6.6	34	6.8	29	5.8	22	4.3	26	5.0
55-59	60	12.1	54	10.9	26	5.3	26	5.3	50	10.1
60-64	49	10.9	64	13.9	22	4.7	29	6.1	49	10.2
65-69	56	14.0	59	14.5	27	6.6	35	8.4	50	11.7
70-74	44	13.3	52	15.0	28	7.8	28	7.6	38	10.1
75-79	57	23.8	44	17.6	22	8.4	28	10.2	34	11.8
80-84	44	26.1	56	32.3	21	11.7	21	11.3	31	16.0
85+	80	43.4	86	45.8	36	18.9	27	13.9	45	22.7
Total	**662**	**8.3**	**692**	**8.5**	**328**	**4.0**	**378**	**4.6**	**552**	**6.6**

* Crude notification rate per 100,000 population

Figure 8. Invasive pneumococcal disease notification rates per 100,000 population by Aboriginality*, age-group and year, NSW, 2018 – 2022



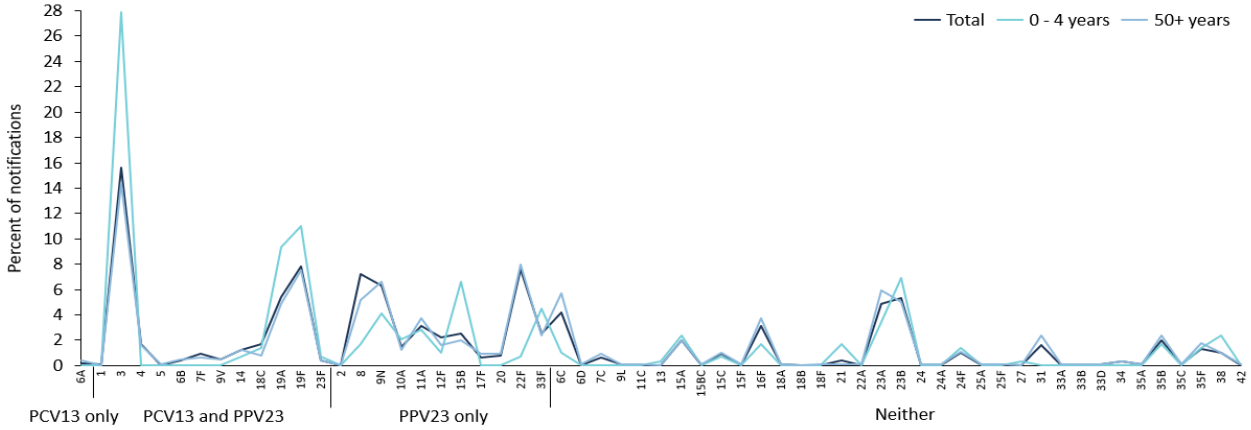
* Non-Aboriginal includes those in which Aboriginality was not reported.

Note: direct comparisons between Aboriginal and non-Aboriginal rates should not be made as rates were not age-standardised.

Serotype

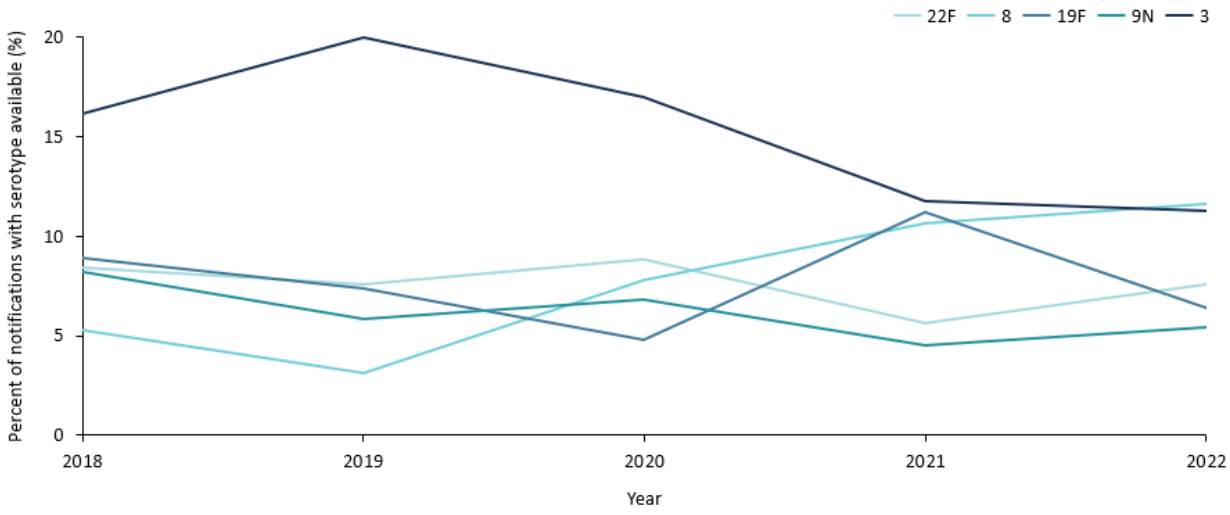
Pneumococcal serotype was known in 2409 (92.2%) cases. Of the remainder, 122 were not typed, 11 were non-typable and serotype was not reported in 70 cases. Of the known types, 864 (35.9%) cases were due to serotypes contained in the PCV13 vaccine, 1686 (70.0%) in the PPV23 and 717 (29.8%) were non-vaccine serotypes. The most common serotypes were 3, followed by 19F (Figure 9). Among serotypes not contained in either vaccine 6C, 23A, 23B and 16F were the most common; counts by serotype are presented in Appendix 3. There were notable changes in the distribution of serotypes 3 (vaccine-type) and 8 (PPV23 vaccine only) over time with the former declining and the latter increasing (Figure 10 and Appendix 3).

Figure 9. *S. pneumoniae* serotypes by vaccine type and age-group, invasive pneumococcal disease notifications*, NSW, 2018 – 2022



*Does not include missing, unknown, not typable or not typed cases.

Figure 10. Distribution of top five *S. pneumoniae* serotypes, invasive pneumococcal disease notifications, NSW, 2018 - 2022



Vaccination status

Vaccination status was reported as fully vaccinated for age in 650 (24.9%) cases, partially vaccinated in 164 (6.3%), unvaccinated in 1,137 (43.5%) and uncertain in 661 (25.3%). Vaccination status by age-group and vaccine-serotype as cause of infection is presented in Table 6. Of the unvaccinated infants aged less than 12 months (n = 25), 15 (60%) were aged less than 1-month and therefore not eligible for vaccine.

Table 6. Reported vaccination status by age and the category of infecting serotype, invasive pneumococcal disease notifications, NSW, 2018 – 2022.

Age at onset	Vaccination status for age	PCV13 serotype only		PCV13 and PPV23 serotype		23PPV only serotype		Non-vaccine serotype		Unknown/Not typed		Total
		n	%	n	%	n	%	n	%	n	%	n
0 - 4 years	Fully	0	0	119	42.2	61	21.6	61	21.6	41	14.5	282
	Partially	0	0	23	53.5	10	23.3	7	16.3	3	7.0	43
	Unvaccinated	0	0	13	37.1	13	37.1	6	17.1	3	8.6	35
	Uncertain	0	0	3	60.0	1	20.0	0	0.0	1	20.0	5
	Total	**0**	**0**	**158**	43.3	**85**	23.3	**74**	20.3	**48**	13.2	**365**
50+ years	Fully	0	0	77	26.6	66	22.8	127	43.9	19	6.6	289
	Partially	1	0.8	32	26.7	27	22.5	52	43.3	8	6.7	120
	Unvaccinated	5	0.5	293	31.2	313	33.4	273	29.1	54	5.8	938
	Uncertain	0	0.0	93	33.8	89	32.4	79	28.7	14	5.1	275
	Total	**6**	0.4	**495**	30.5	**495**	30.5	**531**	32.7	**95**	5.9	**1622**
All ages	Fully	0	0.0	229	35.2	144	22.2	206	31.7	71	10.9	650
	Partially	1	0.6	46	28.0	42	25.6	63	38.4	12	7.3	164
	Unvaccinated	5	0.4	366	32.2	403	35.4	297	26.1	66	5.8	1137
	Uncertain	0	0.0	217	32.8	239	36.2	151	22.8	54	8.2	661
	Total	**6**	0.2	**858**	32.8	**828**	31.7	**717**	27.5	**203**	7.8	**2612**

Case-fatality

There were 235 deaths reported of which 162 (68.9%) were classified as IPD being the cause of death, 19 (8.1%) were considered not caused by IPD and IPD as the cause of death was unknown or not available in 54 (23.0%). Outcome was not reported/collected for 462 notifications.

Among all cases for which outcome was known and IPD was attributed as cause of death (n = 2077), the CF was 7.8%; 1.8% in children aged less than 5-years (6/338 cases) and 10.6% (146/1379) in persons aged 50-years and older. Survival was not reported in 69.4% of cases in other age groups and CF is not reported for those ages. Case-fatality by age-group and Aboriginality in cases with complete data for both variables is presented in Table 7.

Table 7. Invasive pneumococcal disease deaths and case-fatality in which Aboriginality, outcome and cause of death was known, persons aged < 5 years or ≥ 50 years NSW, 2018 – 2022

	Age < 5 years				Age ≥ 50 years			
	Total	Alive	Died*	CF† %	Total	Alive	Died*	CF† %
Aboriginal‡	42	42	0	0	79	70	9	11.4
Non-Aboriginal	296	290	6	2.0	1300	1163	137	10.5
Total	**338**	**332**	**6**	**1.8**	**1379**	**1233**	**146**	**10.6**

*Died: cause of death reported as due to IPD. Excludes cases who were reported as died but cause of death was unknown.
† CF: case fatality
‡Aboriginal: includes persons reported as Torres Strait Islander or Aboriginal and Torres Strait Islander

Among those aged less than 5-years who died due to IPD (n = 6), four were fully vaccinated for age and PCV13 serotypes (19A and 19F) were isolated in two cases. One infant was too young to have been vaccinated and one was partially vaccinated and had acquired a non-PCV13 serotype (9N).

Comment

IPD is a disease that varies epidemiologically within and between countries. COVID-19 was associated with a decline in IPD globally, largely attributed to social restrictions and the disappearance of respiratory viruses, such as influenza, that increase the risk of IPD.[53] Of note, studies suggest pneumococcal carriage was not affected by the pandemic.[54 55] With the return of respiratory viruses in the post-pandemic period, the incidence of IPD has increased in some countries.[56 57] This resurgence has been observed in children without known risk factors[58] highlighting the importance of high vaccine coverage. Given influenza is associated with increased risk of IPD,[59 60] promoting increased uptake of influenza vaccine in persons at high-risk of IPD, is important to preventing the onset and adverse outcomes of disease.

While the current pneumococcal conjugate vaccines have had a substantial impact on IPD epidemiology globally, particularly in children, serotype replacement has occurred.[61] Vaccine failures, while infrequent, do occur. Studies suggest PCV13 is less effective against serotypes 3, 19A and 19F than other serotypes contained in the vaccine,[62] including in Australian children.[63] As new pneumococcal conjugate vaccines covering 15 and 20 serotypes become available, ongoing surveillance of circulating serotypes remains an important public health activity.[63] This is particularly important in populations at high-risk of disease such as young children, the elderly and Aboriginal people. Maintaining high vaccination coverage of existing vaccines in the population is important for sustaining herd immunity, a necessary strategy to protect those partially or unvaccinated and those not eligible for vaccination.

7. Measles

Measles is a highly infectious, serious, viral illness caused by the measles virus (a member of the genus *Morbillivirus* (a paramyxovirus) and is one of the most contagious diseases affecting humans. Measles virus is transmitted from person to person via respiratory droplets produced when an infected person coughs, sneezes or speaks. The measles virus can remain in the air for up to two hours and can be spread prior to the onset of symptoms.

Up to one-third of people with measles will suffer complications (often requiring hospitalisation) including middle ear infection (otitis media), diarrhoea, or pneumonia [64] and 1-3 in 1000 cases will develop encephalitis .[65] Rarely, measles can lead to sub-acute sclerosing pan-encephalitis (SSPE) which can manifest up to a decade after the initial infection and is often fatal.[66]

Prior to the introduction of measles vaccines in the 1960s, measles caused more than two million deaths globally each year.[67] Despite the enormous success of vaccines in reducing measles incidence and mortality, more than 100,000 deaths still occur each year.[67] The WHO declared Australia had eliminated measles in 2014.[68] Most cases are now related to international travel, either in an international visitor or a returned traveller. These are classified as imported cases. Locally acquired secondary cases with a confirmed link to an imported case are classified as import related. Very rarely, locally acquired cases occur which, despite investigation, are unable to be linked to an imported case. These are classified as locally acquired cases.

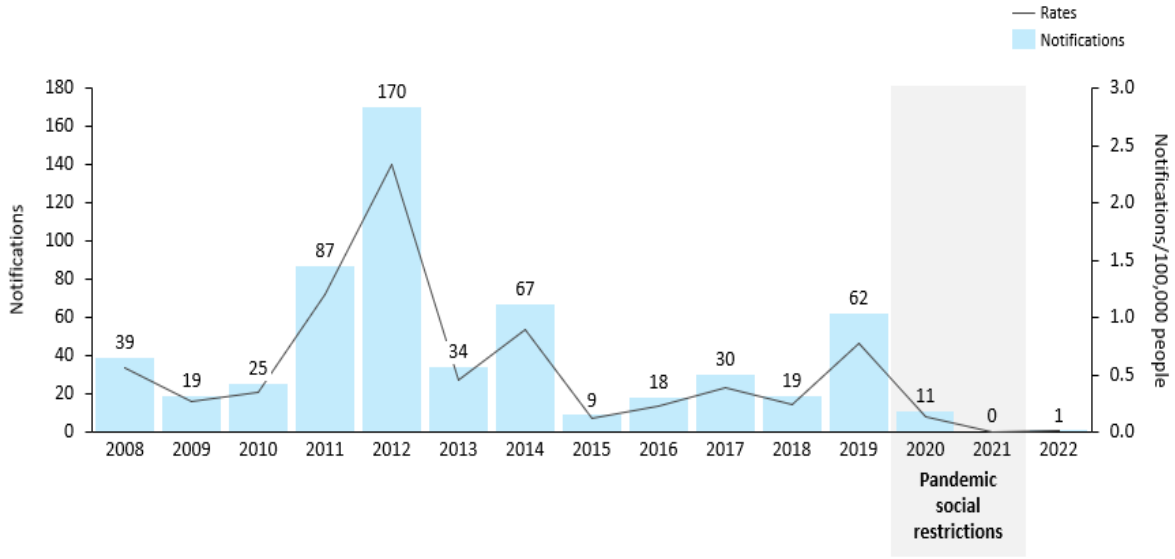
The vaccine

The measles vaccine is a live-attenuated, combination vaccine. There are two combination vaccines which provide protection against measles; MMR vaccine which also protects against mumps and rubella viruses, and MMRV which protects against measles, mumps, rubella, and varicella viruses. Measles vaccine effectiveness in young children after one dose is greater than 90% and 97% after two doses.[69] In Australia, MMR is funded for children at 12-months of age (can be as low as 6-months if the infant is travelling to a high-risk country) with a booster dose of MMRV at 18-months of age. People born between 1966 and 1994 are less likely to have received two doses of a measles vaccine. They are recommended to have an additional dose of vaccine if they have no serological evidence of measles or no documented evidence of two measles vaccines.

Epidemiology

Between 2018 – 2022, there were 93 cases of measles notified in NSW, with 62 (66.7%) of these occurring in 2019 (Figure 11). There were no deaths reported; the outcome was unknown in seven (7.5%) cases.

Figure 11. Measles notifications by year, NSW, 2018 - 2022



Fifty-eight (62.4%) notifications were for males and there was one case in an Aboriginal person; Aboriginality was unknown in four cases. Sixteen notifications were for infants aged less than 12-months. Cases by age-group and vaccination status at time of notification are presented in Table 8.

Of the cases in those aged less than 12-months (n=16), seven (43.8%) were acquired overseas in 2018 and 2019 and all were aged 7–10-months. These infants were age-eligible for measles vaccine given overseas travel but were not vaccinated. The one case in a person aged over 65-years, a rare occurrence, could not recall having had natural measles infection, nor having received measles vaccination in the past.

Table 8. Measles notifications by age-group and vaccination status, NSW, 2018 – 2022.

Age -group (years)	Fully vaccinated		Partially vaccinated		Not vaccinated		Uncertain		Total
	n	%	n	%	n	%	n	%	N
0	0	0.0	0	0.0	16	100.0	0	0.0	16
1	0	0.0	0	0.0	2	100.0	0	0.0	2
2-4	0	0.0	0	0.0	1	100.0	0	0.0	1
5-9	0	0.0	0	0.0	2	66.7	1	33.3	3
10-14	1	11.1	1	11.1	6	66.7	1	11.1	9
15-24	6	35.3	1	5.9	4	23.5	6	35.3	17
25-44	3	7.5	7	17.5	7	17.5	23	57.5	40
45-64	0	0.0	0	0.0	0	0.0	4	100.0	4
65-74	0	0.0	0	0.0	1	100.0	0	0.0	1
75+	0	0.0	0	0.0	0	0.0	0	0.0	0
Total	**10**	**10.8**	**9**	**9.7**	**39**	**41.9**	**35**	**37.6**	**93**

Percentages reported are the proportion of individuals in each age group within vaccination status category (row percent)

Forty-three (46%) cases occurred in people born between 1966 and 1994, the cohort less likely to be age-appropriately vaccinated given the timing of the introduction of measles vaccination, including a second

dose, in Australia. Of these, three (7%) had a record of having received two doses of a measles containing vaccine; seven (16%) had a record of one dose and seven (16%) were unvaccinated; vaccination history was uncertain in 26 (60%) cases.

Place of acquisition

Of the 93 cases, 40 (43.0%) were acquired in NSW, one interstate and 49 (52.7%) overseas; place of acquisition was unknown in four cases. Of the 40 locally acquired cases, 17 were considered import related. The majority of these occurred in 2019 and the first three months of 2020.

Comment

The international epidemiology of measles significantly impacts that of Australia. Increased notifications and local outbreaks are often associated with travel to places overseas considered at high risk for measles. Historically these have included places which are common destinations for Australian travellers or sources of visitors such as South, and South-East Asia, and the Pacific. However, in the years immediately preceding the COVID-19 pandemic, the source of measles infections in Australia had been expanding to include places previously considered low risk for measles, as a result of reductions in vaccination coverage and increasing cases internationally.[70-74]

The increase in cases in 2019 aligned with large outbreaks and increases in cases overseas in places previously considered low risk for measles including the Pacific Islands (2 importations) and New Zealand (5 importations, 3 outbreaks), South America (1 importation, 1 outbreak), Europe (1 importation, 1 outbreak), and the United Kingdom (1 importation). However, 50% of imported cases acquired their infection in a location known to be high risk for measles, and/or historically a common source of measles infection in NSW. These included the Philippines (14 importations, 27% of imported cases), Thailand (8 importations, 16% of imported cases, 2 outbreaks) and Indonesia (2 importations, 4% of imported cases, 1 outbreak).

Most measles cases in NSW occur in adults in the age-group less likely to have had two doses of measles vaccine in early childhood. This is followed by infants too young to be vaccinated or, given vaccine can be given from 6-months of age, not vaccinated prior to travel to high-risk areas. Preventing measles transmission in Australia will continue to be highly dependent on maintaining high-vaccine coverage. This includes the need for travellers to be adequately informed of the risks of measles in countries they are visiting and ensuring vaccination is up to date prior to travel.

8. Mumps

Mumps is an acute illness caused by the mumps virus (scientific name *Mumps orthorubulavirus)* which is a paramyxovirus.[75] Common symptoms include fever, loss of appetite, tiredness and headaches followed by swelling and tenderness of the salivary glands. Complications are rare but can be serious including encephalitis and meningitis, orchitis (infection of the testes), spontaneous abortion and hearing loss.[75] Humans are the only natural host of the mumps virus. The virus is transmitted through contact with respiratory secretions, usually from respiratory droplets through the airborne route but also through direct contact with the saliva of an infected person.[75]

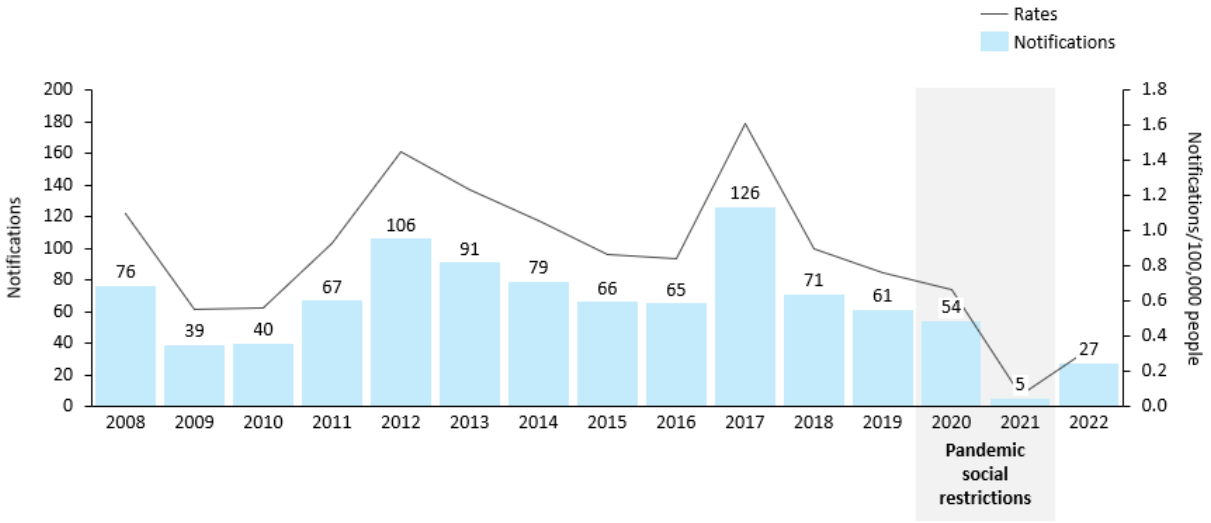
The vaccine

The mumps vaccine is a live attenuated vaccine. There are two combination vaccines which provide protection against mumps; MMR vaccine which also protects against measles and rubella viruses, and MMRV which protects against measles, mumps, rubella, and varicella viruses. The mumps component is not as immunogenic as the measles and rubella components and protection may wane over time.[76] In 2013, the recommendation for a second dose of MMR at 4-years of age was changed to 18-months.[77]

Epidemiology

There were 218 mumps cases reported for the period 2018-2022 compared to 430 for 2013-2017. The 2013-2017 period was impacted by a peak of 128 cases in 2017, the highest number reported since 2008 (Figure 12). Only five cases were reported in 2021, the lowest since notifications began in NSW in 1991. An outbreak of mumps in a football team was reported in 2018, with 12 cases identified between 21 January – 10 February.[78] The median age in that outbreak was 25-years (range 18 – 39) and the attack rate was estimated to be 21%.[78]

Figure 12. Mumps notifications by year, NSW, 2008 - 2022



Males accounted for 124 (56.9%) of notifications and there were five (2.3%) notifications for Aboriginal persons; Aboriginality was not reported for 18 (8.3%) cases. While there was some year-to-year variation, persons aged 15–64 years comprised the highest proportion of notifications over the 5-year period (Table 9).

Table 9. Mumps notifications by age-group and year, NSW, 2018 – 2022.

Age-group (years)	2018		2019		2020		2021		2022		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
0	0	0	0	0.0	1	1.9	0	0	0	0.0	10	4.6
1	2	2.8	5	8.2	2	3.7	0	0	1	3.7	10	4.6
2-4	3	4.2	7	11.5	4	7.4	1	20	6	22.2	21	9.6
5-9	2	2.8	2	3.3	2	3.7	0	0	4	14.8	10	4.6
10-14	3	4.2	1	1.6	3	5.6	0	0	1	3.7	8	3.7
15-24	14	19.7	7	11.5	15	27.8	0	0	4	14.8	40	18.3
25-44	31	43.7	19	31.1	20	37.0	1	20	3	11.1	74	33.9
45-64	11	15.5	10	16.4	6	11.1	3	60	6	22.2	36	16.5
65-74	3	4.2	7	11.5	0	0.0	0	0	1	3.7	11	5.0
75-84	1	1.4	2	3.3	1	1.9	0	0	1	3.7	5	2.3
85+	1	1.4	1	1.6	0	0.0	0	0	0	0.0	2	0.9
Total	**71**	**100**	**61**	**100**	**54**	**100**	**5**	**100**	**27**	**100**	**218**	**100**

Percentages reported are the proportion of individuals by age group within a year (row percent)

Infection was acquired in NSW in 122 (56.0%) cases between 2018 - 2022, one (0.5%) was interstate and 21 (9.6%) were overseas; place of acquisition was missing or unknown for 74 (33.9%) cases. There were no deaths reported between 2018-2022; outcome was not available for 25 (11.5%) cases.

Among children aged less than 10-years (n = 42), 35 were reported as fully vaccinated for age, one partially, three unvaccinated, one too young to be vaccinated (7-months of age); vaccination status was uncertain in two cases. Among those aged 10 – 24 years (n = 48), 18 were reported as fully vaccinated, three partially vaccinated, eight unvaccinated and uncertain in 19 cases. Among those aged 25-years and older (n = 128), 10 were fully vaccinated for age, four partially, 15 unvaccinated and uncertain in 99 cases.

Comment

The introduction of the MMR vaccine led to large reductions in disease in countries with high vaccine coverage, including Australia. However sporadic outbreaks of mumps continue to occur, with increasing incidence being observed in adolescents and young adults,[79] particularly in culturally and linguistically diverse subpopulations with limited transmission into the wider community.[80] The reasons for this are not well understood however waning immunity and the emergence of strains genetically different to those in the vaccine are potential factors.[81] Outbreaks in specific subpopulations may also be a factor of mobility, household crowding or other intense exposure settings.[80] In Australia, over the last 15 years large outbreaks have occurred amongst vaccinated young people and Aboriginal populations in Western Australia, Queensland and the Northern Territory.[82-84]

9. Pertussis

Pertussis, also known as 'whooping cough', is a highly contagious infection affecting the respiratory system caused by the bacterium *Bordetella pertussis*. It affects individuals of all ages but is more severe (and can be fatal) in small babies, particularly those too young to be vaccinated or those who are unvaccinated.[85] Maternal pertussis vaccination in pregnancy provides protection against infection in infants up to 8-months of age, with effectiveness highest in those aged less than 2-months.[86] In the absence of vaccination, almost everyone will develop whooping cough in infancy and childhood.[85] Elderly people are also at increased risk of developing complications from pertussis. Pertussis is an endemic disease with epidemic peaks typically occurring every 3 – 4 years.[85] In Australia, pertussis is usually a seasonal illness with peaks occurring in spring and summer.[87]

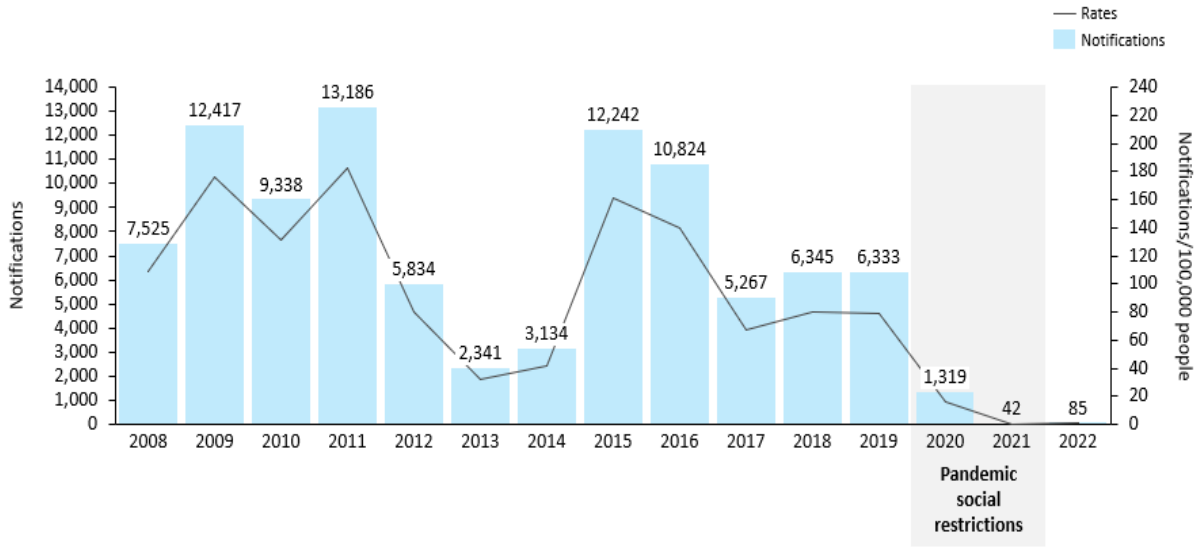
The vaccine

Pertussis vaccine is given to infants and children in NSW at 6-weeks, 4-, 6- and 18-months and 4-years of age and in Year 7 of school. Pertussis vaccine is also funded for pregnant women at between 20 – 32 weeks gestation each pregnancy. Vaccination is recommended every 10 years for healthcare workers, early childhood educators and carers, and those in close contact with infants. Pertussis vaccines in use in Australia are acellular vaccines delivered in combination vaccines with diphtheria and tetanus toxoid. Acellular vaccines contain purified inactivated pertussis toxin in combination or alone with other *B. pertussis* components.[85] They differ to previously used whole-cell pertussis vaccines which were suspensions of the entire inactivated *B. pertussis* bacterium.[85] Acellular vaccines are associated with less side effects than whole-cell vaccines when multiple doses are required in a schedule however they can also generate a lower antibody response.[85]

Epidemiology

During 2018 – 2022, there were 14,124 notifications of pertussis in NSW with 88% of these notified prior to the COVID-19 pandemic (Figure 13). Pertussis notifications declined rapidly in 2020 and were at exceptionally low levels throughout 2021 and 2022.

Figure 13. Pertussis notifications by year, NSW, 2008 - 2022



Females accounted for 7580 (53.7%) notifications and 6409 (45.4%) cases were in children aged 5 – 14-

years (Table 10). There were 451 (3.2%) notifications for infants aged less than 12-months, 195 (43.2%) of these were in infants aged less than 6-months.

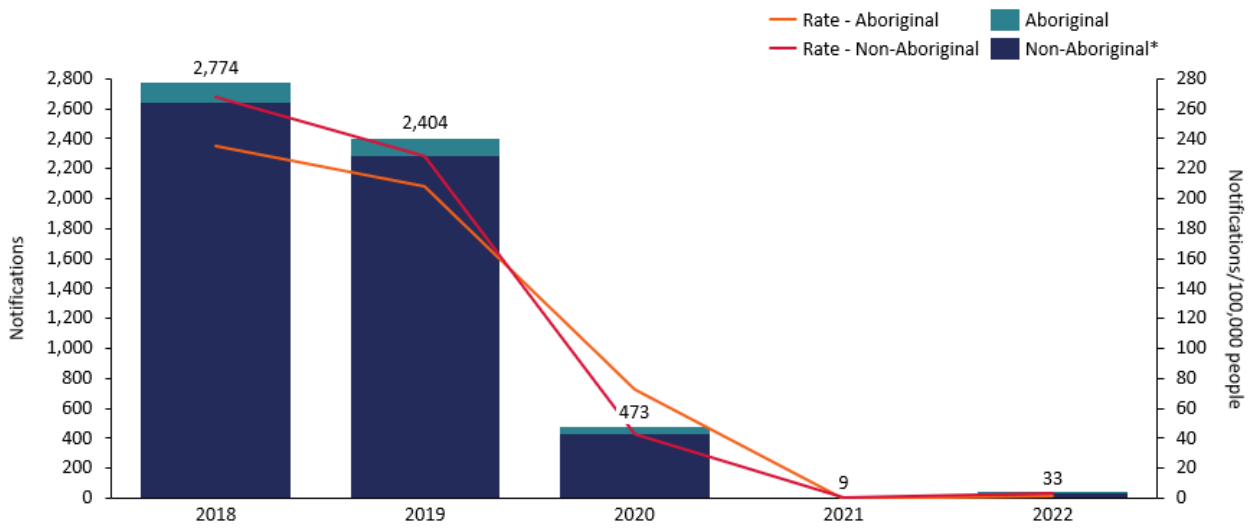
Table 10. Pertussis notifications by age-group and year, NSW, 2018 – 2022

Age-group (years)	2018		2019		2020		2021		2022	
	N	Rate*	N	Rate*	N	Rate*	N	Rate*	N	Rate*
0-4	890	164.7	831	152.5	211	38.6	8	1.5	27	4.9
5-9	1884	375.0	1573	308.0	262	50.4	1	0.2	6	1.1
10-14	1185	247.2	1276	261.9	213	43.1	4	0.8	5	1.0
15-19	328	72.0	446	96.9	78	16.7	3	0.6	2	0.4
20-24	148	31.6	221	46.6	60	12.4	1	0.2	4	0.8
25-29	185	33.1	181	32.5	44	7.9	0	0.0	3	0.5
30-34	203	34.2	205	34.2	61	10.1	4	0.7	2	0.3
35-39	235	41.6	231	39.9	50	8.5	4	0.7	1	0.2
40-44	247	47.1	251	47.5	53	9.9	2	0.4	1	0.2
45-49	243	45.7	260	48.6	78	14.6	1	0.2	3	0.6
50-54	185	37.3	231	46.2	53	10.5	3	0.6	4	0.8
55-59	168	33.9	157	31.7	38	7.7	2	0.4	4	0.8
60-64	129	28.7	123	26.8	35	7.5	1	0.2	2	0.4
65-69	101	25.2	102	25.1	30	7.3	4	1.0	6	1.4
70-74	92	27.8	102	29.5	14	3.9	2	0.5	8	2.1
75-79	58	24.2	75	30.0	12	4.6	1	0.4	4	1.4
80-84	34	20.2	37	21.3	14	7.8	1	0.5	1	0.5
85+	29	15.7	30	16.0	13	6.8	0	0.0	2	1.0
Total	**6344**	**79.4**	**6332**	**78.2**	**1319**	**16.1**	**42**	**0.5**	**85**	**1.0**

* Crude rate per 100,000 population

Of the 5,693 notifications for children aged less than 10-years, 290 (5.1%) were for Aboriginal children; Aboriginality was not reported in 1448 (25.4%). Notifications and notification rates per 100,000 by Aboriginality and year for children aged less than 10-years are presented in Figure 14. There were no deaths reported; outcome was unknown or not available in 3113 (54.7%) notifications.

Figure 14. Pertussis notifications, children aged less than 10 years, by Aboriginality and year, NSW, 2018 - 2022



* Non-Aboriginal: includes persons for whom Aboriginality was unknown or not reported.

Vaccination status was reported in 4063 (71.4%) notifications for children aged less than 10-years. Of these, 3613 (88.9%) were reported as fully vaccinated for age, 217 (5.3%) were partially vaccinated for age and 233 (5.7%) were unvaccinated for age. Vaccination status by age for children less than 5-years for whom vaccination status was more complete is presented in Table 11. There were six infants aged less than 1-month who were too young to have received any vaccine prior to disease onset. Vaccination status by age in months and Aboriginality for infants aged less than 12-months is presented in Appendix 3.

Table 11. Reported vaccination status* by age, pertussis notifications in children aged less than 5-years, NSW, 2018 – 2022.

	Fully Vaccinated		Partially vaccinated		Unvaccinated		Uncertain		Total
Age in years	n	%	n	%	n	%	n	%	N
0	341	75.6	50	11.1	36	8.0	24	5.3	451
1	320	81.2	33	8.4	24	6.1	17	4.3	394
2	312	87.4	13	3.6	25	7.0	7	2.0	357
3	395	85.7	18	3.9	26	5.6	22	4.8	461
4	239	78.6	39	12.8	21	6.9	5	1.6	304
Total	**1607**	**81.7**	**153**	**7.8**	**132**	**6.7**	**75**	**3.8**	**1967**

*As per recommended number of vaccines a child should have received for age at time of notification.

In notifications for infants aged less than 6-months (n = 195), maternal vaccination in pregnancy was reported in 161 (82.6%) cases, 28 (14.5%) females were not vaccinated, and status was unknown or not available in six (3.1%). Gestational age at time of vaccination was not collected.

Comment

Pertussis epidemics can occur every three or four years despite high vaccination rates.[85] This is due to incomplete protection from the vaccine in some people and waning immunity over time from both

infection and vaccination.[85] Among children aged less than 5-years notified with pertussis, 82% were age-appropriately vaccinated. This reflects the high vaccination coverage in young children in NSW and that estimated vaccine effectiveness against pertussis in children during epidemics can range between 70 to 90% depending on age.[85] Pertussis in vaccinated individuals, including babies and young children, is usually less severe than in the unvaccinated.[85] Being vaccinated on time is important in infants, with recent Australian data suggesting 85 (95% CI: 61-109) cases per 100,000 infants, could have been prevented if all infants with delayed doses had received their three doses within the on-time window.[88]

The decline in pertussis during the COVID-19 pandemic was reported in multiple countries and attributed to the social restrictions in place.[89-92] However, global disruption to vaccine uptake also occurred with declines in coverage of routine immunisations, including pertussis observed in several regions.[93] While gains were made in 2022, coverage did not reach pre-pandemic levels.[93] Declines in vaccine coverage were also observed in pregnant women, including in parts of Australia.[93 94 95] Pertussis vaccination in pregnancy protects the newborn. While pertussis vaccine uptake in pregnant women is improving in Australia, further efforts are needed to address vaccine hesitancy and ready access to vaccines in pregnancy.

10. Rubella

The disease

Rubella (also known as German measles) is an acute viral disease caused by the rubella virus which is different to the measles virus. The illness is usually mild, and symptoms include fever, runny nose, conjunctivitis and a rash which starts on the face and spreads to the rest of the body.[96]

Rubella virus is transmitted via direct contact with respiratory droplets spread by infected persons coughing or sneezing. Humans are the only source of infection.[96] Rubella infection during pregnancy may lead to foetal infection which can result in miscarriage, still birth, or congenital rubella syndrome (CRS).[97] Congenital infection after maternal rubella can be as high as 80% during the first 12 weeks of pregnancy, 54% at 13-14 weeks, and 25% at the end of the second trimester.[97] CRS is characterised by several abnormalities in the foetus/infant including intellectual disabilities, cataracts, deafness, heart abnormalities, intrauterine growth retardation, and inflammatory lesions of the brain, liver, lungs, and bone marrow.

In 2018, the WHO declared Australia had eliminated endemic rubella virus.[98] This was predominantly due to achieving and maintaining high rates of vaccination.

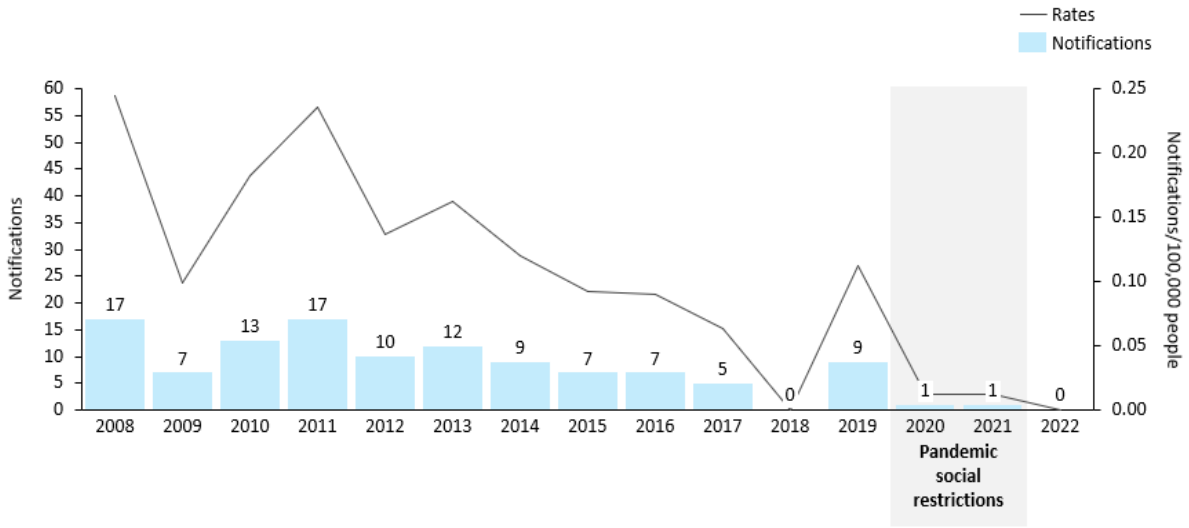
The vaccine

The rubella vaccine is a live-attenuated vaccine and delivered as part of the combined MMR or MMRV vaccines at 12- and 18-months of age. Rubella antibodies can wane over time. Pregnant women are routinely screened for rubella antibodies and, if necessary, a booster dose provided after delivery of the baby. As it is a live vaccine, rubella vaccine should not be given during pregnancy.[5]

Epidemiology

From 2018 – 2022, 11 cases of rubella were notified, nine in 2019 and one each in 2020 and 2021. Notifications and notification rates per 100,000 population by year are presented in Figure 15. Of these, seven (63.6%) were for females, all aged between 23 – 41 years. Of the males, one was aged less than 12-months and three were aged between 20 – 35 years. One case was notified in an Aboriginal person; Aboriginality was not reported in one case.

Figure 15. Rubella notifications by year, NSW, 2008 - 2022



Four females were reported as pregnant at the time of illness, pregnancy status was not reported for one female who was of child-bearing age. Gestational age at time of infection is not collected. There were no cases of CRS notified and the only case in an infant was in a 6-month-old too young to be vaccinated.

Vaccination status for the females was uncertain in six cases. One pregnant woman was reported as fully vaccinated for age with the second dose of MMR vaccine received 22-years prior to disease onset. For males, vaccination status was uncertain in three of the four cases; the remaining male was an infant too young to be vaccinated.

Seven of the cases notified in 2019 were acquired in NSW and two were acquired in China. Place of acquisition was not reported in the two cases notified in 2020 and 2021. All cases with reported acquisition in NSW in 2019 occurred in the first quarter of the year and were in residents of four metropolitan LHDs. The two cases acquired in China occurred in February 2019 however the cases were unrelated.

Comment

The increase in rubella notifications observed in the first quarter of 2019 was observed nationally, considered potentially related to increases in the Asia-Pacific region and use of more sensitive tests in a time of high measles activity globally.[99] Rubella in pregnancy continues to occur along with the risk of CRS. Females of child-bearing age considering pregnancy with uncertain vaccination status should have antibodies checked and be vaccinated if they have no evidence of immunity.[5]

11. Tetanus

The disease

Tetanus is caused by the bacterium *Clostridium tetani*, an organism which is commonly found in soil, dust and animal faeces. Disease occurs when the organism enters the body through a break in the skin (such as a puncture wound); it is not transmitted between people.[100] Toxin produced by the bacterium attacks the central nervous system causing muscle rigidity with painful spasms, including the characteristic muscle spasms of the jaw ("lock jaw"). Tetanus can be life-threatening and even with treatment up to one in 10 people with tetanus will die.[101] Since 1990, the number of deaths globally from tetanus has fallen by 88%.[101]

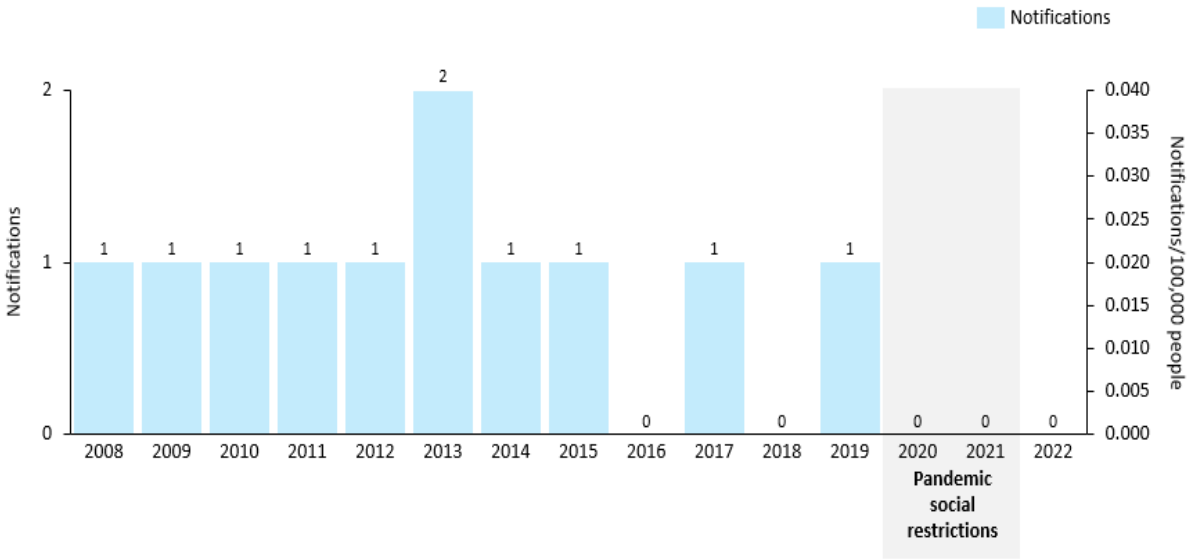
The vaccine

The tetanus vaccine protects against the toxin produced by the bacteria and can be given after injury to prevent illness. In Australia, the tetanus vaccine is part of the combined tetanus-diphtheria-pertussis vaccine or diphtheria-tetanus vaccines.[5] Infants and children receive funded vaccine at 6-weeks, 4-, 6- and 18-months and at 4-years of age and in Year 7 of school. Adults aged 50-years and 65-years and older are recommended to receive tetanus vaccine if their last dose was more than 10-years ago.

Epidemiology

There was one case of tetanus notified between 2018 – 2022 compared to five cases for the period 2013 – 2017. The single case of tetanus occurred in a female aged greater than 75 years with a dose of tetanus vaccine received four years prior. The person survived the illness. For the 10-year period 2008 – 2022, 12 cases of tetanus were notified (Figure 16) of which 6 (50%) were in persons aged 75 years and older.

Figure 16. Tetanus notifications by year, NSW, 2008 – 2022.



Comment

Given high uptake of tetanus vaccines following its introduction in Australia from 1953, tetanus is a rare disease in Australia.[100] It now predominantly affects older adults, particularly females,[102] with waning immunity given advancing age and time since last dose of tetanus vaccine.[103] Assessing the tetanus vaccination status for older persons at other immunisation milestones and/or at routine health checks in primary care is important to prevent disease in this age-group.

The absence of tetanus cases in NSW between 2020 – 2022 is difficult to attribute solely to the pandemic given the small number of cases notified annually and that tetanus is not transmissible. There appears to be

no published reports of reductions in tetanus incidence elsewhere. The pandemic did however impact on routine vaccination services globally[104] and, while gains have been made in restoring services to pre-pandemic levels, there are likely to be children and adults vulnerable to tetanus.

12. References

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Appendix 1. Vaccine-preventable diseases in NSW not included in this report.

Table A1. Location of data and/or reports for other vaccine preventable diseases in NSW

Disease	Location of report or data available
Cervical cancer	Cancer Statistics NSW: https://www.cancer.nsw.gov.au/research-and-data/cancer-data-and-statistics/data-available-now/cancer-statistics-nsw
Chickenpox	Presentations to NSW public emergency departments with an assigned diagnosis of chickenpox NSW Health. A-Z of infectious diseases. https://www.health.nsw.gov.au/Infectious/diseases/Pages/default.aspx
COVID-19	NSW Respiratory Report: https://www.health.nsw.gov.au/Infectious/covid-19/Pages/reports.aspx NSW Health. A-Z of infectious diseases. https://www.health.nsw.gov.au/Infectious/diseases/Pages/default.aspx
Hepatitis A	NSW Health. A-Z of infectious diseases. https://www.health.nsw.gov.au/Infectious/diseases/Pages/default.aspx
Hepatitis B	Hepatitis B and C annual data reports: https://www.health.nsw.gov.au/hepatitis/Pages/resources.aspx NSW Health. A-Z of infectious diseases. https://www.health.nsw.gov.au/Infectious/diseases/Pages/default.aspx
Influenza	NSW Respiratory Report: https://www.health.nsw.gov.au/Infectious/covid-19/Pages/reports.aspx NSW Health. A-Z of infectious diseases. https://www.health.nsw.gov.au/Infectious/diseases/Pages/default.aspx
Japanese encephalitis	NSW Vector-borne diseases reports. https://www.health.nsw.gov.au/Infectious/reports/Pages/vbd-reports.aspx NSW Health. A-Z of infectious diseases. https://www.health.nsw.gov.au/Infectious/diseases/Pages/default.aspx
MPox	To be included from 2022 in the NSW Sexually transmitted infections surveillance reports: https://www.health.nsw.gov.au/Infectious/reports/Pages/STI-reports.aspx NSW Health. A-Z of infectious diseases. https://www.health.nsw.gov.au/Infectious/diseases/Pages/default.aspx
Q Fever	NSW Zoonoses annual reports. https://www.health.nsw.gov.au/Infectious/reports/Pages/zoonoses-reports.aspx NSW Health. A-Z of infectious diseases. https://www.health.nsw.gov.au/Infectious/diseases/Pages/default.aspx
Rotavirus	NSW OzFoodNet Report: https://www.health.nsw.gov.au/Infectious/foodborne/Pages/ozfoodnet-rpt.aspx# NSW Health. A-Z of infectious diseases. https://www.health.nsw.gov.au/Infectious/diseases/Pages/default.aspx

Shingles	Presentations to NSW public emergency departments with an assigned diagnosis of shingles. NSW Health. A-Z of infectious diseases. https://www.health.nsw.gov.au/Infectious/diseases/Pages/default.aspx
Typhoid	NSW OzFoodNet Report: https://www.health.nsw.gov.au/Infectious/foodborne/Pages/ozfoodnet-rpt.aspx# NSW Health. A-Z of infectious diseases. https://www.health.nsw.gov.au/Infectious/diseases/Pages/default.aspx

Appendix 2. Pneumococcal serotypes in NSW 2018-2022

Table A2. *S. pneumoniae* serotypes reported for invasive pneumococcal disease notifications by vaccine-type and age-group, NSW, 2018-2022

		Total		< 5 years		50+ years	
		n	%	n	%	n	%
PCV13 only	**6A**	6	0.2	0	0.0	6	1.1
PCV13 and PPV23	**1**	3	0.1	0	0.0	0	0.0
	3	375	15.6	81	27.9	220	41.7
	4	42	1.7	0	0.0	24	4.6
	5	1	0.0	0	0.0	1	0.2
	6B	9	0.4	0	0.0	8	1.5
	7F	22	0.9	0	0.0	9	1.7
	9V	12	0.5	0	0.0	8	1.5
	14	28	1.2	2	0.7	18	3.4
	18C	40	1.7	4	1.4	12	2.3
	19A	129	5.4	27	9.3	75	14.2
	19F	188	7.8	32	11.0	114	21.6
	23F	9	0.4	2	0.7	6	1.1
PPV23 only	**2**	1	0.0	0	0.0	0	0.0
	8	173	7.2	5	1.7	80	15.2
	9N	151	6.3	12	4.1	101	19.2
	10A	36	1.5	6	2.1	18	3.4
	11A	75	3.1	8	2.8	56	10.6
	12F	52	2.2	3	1.0	25	4.7
	15B	61	2.5	19	6.6	30	5.7
	17F	15	0.6	0	0.0	13	2.5
	20	19	0.8	0	0.0	14	2.7
	22F	184	7.6	2	0.7	122	23.1
	33F	61	2.5	13	4.5	36	6.8
Neither	**6C**	101	4.2	3	1.0	87	16.5
	6D	1	0.0	0	0.0	1	0.2
	7C	14	0.6	0	0.0	13	2.5
	9L	2	0.1	0	0.0	2	0.4
	11C	1	0.0	0	0.0	1	0.2
	13	1	0.0	1	0.3	0	0.0
	15A	47	2.0	7	2.4	30	5.7
	15B	1	0.0	0	0.0	1	0.2
	15C	21	0.9	2	0.7	15	2.8
	15F	1	0.0	0	0.0	1	0.2
	16F	74	3.1	5	1.7	57	10.8
	18A	3	0.1	0	0.0	1	0.2

18B	1	0.0	0	0.0	0	0.0
18F	1	0.0	0	0.0	1	0.2
21	10	0.4	5	1.7	2	0.4
22A	1	0.0	0	0.0	1	0.2
23A	118	4.9	10	3.4	90	17.1
23B	128	5.3	20	6.9	77	14.6
24	1	0.0	0	0.0	1	0.2
24A	1	0.0	0	0.0	1	0.2
24F	24	1.0	4	1.4	17	3.2
25A	1	0.0	0	0.0	1	0.2
25F	2	0.1	0	0.0	2	0.4
27	1	0.0	1	0.3	0	0.0
31	39	1.6	0	0.0	36	6.8
33A	1	0.0	0	0.0	1	0.2
33B	1	0.0	0	0.0	1	0.2
33D	2	0.1	0	0.0	2	0.4
34	8	0.3	0	0.0	5	0.9
35A	2	0.1	0	0.0	2	0.4
35B	48	2.0	5	1.7	36	6.8
35C	2	0.1	0	0.0	2	0.4
35F	32	1.3	4	1.4	27	5.1
38	25	1.0	7	2.4	16	3.0
42	1	0.0	0	0.0	1	0.2
Total	2409	100	290	100	1527	100

Appendix 3. *S. pneumoniae* serotype distribution by year

Table A3. Frequency of *S. pneumoniae* serotypes identified in invasive pneumococcal disease notifications, NSW, 2018 - 2022

	2018		2019		2020		2021		2022		Total*	
	n	%	n	%	n	%	n	%	n	%	n	%
3	98	16.1	125	19.7	53	17.4	43	12.0	56	11.0	375	15.5
19F	55	9.1	48	7.5	14	4.6	40	11.1	33	6.5	190	7.9
22F	50	8.2	49	7.7	27	8.9	20	5.6	39	7.6	185	7.7
8	32	5.3	20	3.1	23	7.6	38	10.6	60	11.7	173	7.2
9N	50	8.2	38	6.0	20	6.6	16	4.5	28	5.5	152	6.3
19A	40	6.6	33	5.2	18	5.9	11	3.1	27	5.3	129	5.3
23B	27	4.4	33	5.2	13	4.3	28	7.8	28	5.5	129	5.3
23A	32	5.3	27	4.2	11	3.6	19	5.3	29	5.7	118	4.9
6C	30	4.9	36	5.7	8	2.6	9	2.5	18	3.5	101	4.2
11A	11	1.8	18	2.8	8	2.6	13	3.6	25	4.9	75	3.1
16F	9	1.5	20	3.1	14	4.6	17	4.7	14	2.7	74	3.1
15B	6	1.0	11	1.7	12	3.9	20	5.6	13	2.5	62	2.6
33F	14	2.3	13	2.0	4	1.3	6	1.7	24	4.7	61	2.5
12F	14	2.3	20	3.1	9	3.0	9	2.5	0	0.0	52	2.2
35B	13	2.1	12	1.9	6	2.0	6	1.7	12	2.3	49	2.0
15A	15	2.5	12	1.9	9	3.0	4	1.1	7	1.4	47	1.9
4	7	1.2	5	0.8	5	1.6	12	3.3	14	2.7	43	1.8
18C	5	0.8	7	1.1	6	2.0	9	2.5	13	2.5	40	1.7
31	17	2.8	7	1.1	2	0.7	5	1.4	8	1.6	39	1.6
10A	6	1.0	10	1.6	8	2.6	4	1.1	8	1.6	36	1.5
35F	8	1.3	3	0.5	2	0.7	7	1.9	12	2.3	32	1.3
14	14	2.3	10	1.6	1	0.3	1	0.3	2	0.4	28	1.2
38	5	0.8	12	1.9	2	0.7	1	0.3	5	1.0	25	1.0
24F	6	1.0	7	1.1	5	1.6	5	1.4	1	0.2	24	1.0
7F	5	0.8	11	1.7	4	1.3	2	0.6	0	0.0	22	0.9
15C	8	1.3	7	1.1	2	0.7	1	0.3	3	0.6	21	0.9
20	1	0.2	9	1.4	5	1.6	2	0.6	2	0.4	19	0.8
17F	2	0.3	5	0.8	5	1.6	0	0.0	3	0.6	15	0.6
7C	1	0.2	6	0.9	2	0.7	1	0.3	4	0.8	14	0.6
9V	4	0.7	4	0.6	0	0.0	0	0.0	4	0.8	12	0.5
21	1	0.2	0	0.0	1	0.3	3	0.8	5	1.0	10	0.4
23F	6	1.0	2	0.3	1	0.3	0	0.0	0	0.0	9	0.4
6B	1	0.2	2	0.3	2	0.7	2	0.6	2	0.4	9	0.4
34	1	0.2	3	0.5	1	0.3	1	0.3	2	0.4	8	0.3
6A	4	0.7	1	0.2	0	0.0	1	0.3	0	0.0	6	0.2
1	2	0.3	0	0.0	1	0.3	0	0.0	0	0.0	3	0.1
18A	0	0.0	0	0.0	0	0.0	1	0.3	2	0.4	3	0.1

25F	2	0.3	0	0.0	0	0.0	0	0.0	0	0.0	2	0.1
33D	0	0.0	1	0.2	0	0.0	1	0.3	0	0.0	2	0.1
35A	0	0.0	1	0.2	0	0.0	0	0.0	1	0.2	2	0.1
35C	0	0.0	1	0.2	0	0.0	0	0.0	1	0.2	2	0.1
9L	1	0.2	1	0.2	0	0.0	0	0.0	0	0.0	2	0.1
2	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
5	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	1	0.0
13	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	1	0.0
24	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
27	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	1	0.0
42	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	1	0.0
11C	0	0.0	0	0.0	0	0.0	1	0.3	0	0.0	1	0.0
15B	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	1	0.0
15F	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	1	0.0
18B	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	1	0.0
18F	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	1	0.0
22A	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	1	0.0
24A	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
25A	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
33A	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	1	0.0
33B	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	1	0.0
6D	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	1	0.0
Total	607	100	636	100	304	100	359	100	511	100	2417	100

* Total excludes notifications for which serotype was untypable, not typed or not reported

Appendix 4. Vaccination status of infant pertussis cases

Table A4. Vaccination status of infants aged less than 12-months notified with pertussis, by age in months and Aboriginality, NSW, 2018 - 2022

Age in months	Fully		Partially		No		Uncertain		Total
	n	%	n	%	n	%	n	%	n
	Aboriginal and/or Torres Strait Islander								
0	0	0.0	0	0.0	1	100.0	0	0.0	1
1	2	100.0	0	0.0	0	0.0	0	0.0	2
2	4	80.0	1	20.0	0	0.0	0	0.0	5
3	5	83.3	0	0.0	0	0.0	1	16.7	6
4	8	88.9	0	0.0	1	11.1	0	0.0	9
5	3	60.0	2	40.0	0	0.0	0	0.0	5
6	1	33.3	1	33.3	0	0.0	1	33.3	3
7	3	60.0	2	40.0	0	0.0	0	0.0	5
8	5	100.0	0	0.0	1	20.0	0	0.0	5
9	1	50.0	0	0.0	0	0.0	1	50.0	2
10	1	100.0	0	0.0	0	0.0	0	0.0	1
11	1	100.0	0	0.0	0	0.0	0	0.0	1
Total	***34***	***75.6***	***6***	***13.3***	***3***	***6.7***	***3***	***6.7***	***45***
	Not Aboriginal or Torres Strait Islander								
0	0	0.0	0	0.0	5	100.0	0	0.0	5
1	7	33.3	0	0.0	13	61.9	1	4.8	21
2	18	78.3	1	4.3	2	8.7	2	8.7	23
3	24	85.7	2	7.1	1	3.6	1	3.6	28
4	24	72.7	6	18.2	2	6.1	1	3.0	33
5	27	69.2	7	17.9	3	7.7	2	5.1	39
6	21	63.6	10	30.3	1	3.0	1	3.0	33
7	29	69.0	7	16.7	3	7.1	3	7.1	42
8	39	95.1	1	2.4	0	0.0	1	2.4	41
9	30	78.9	5	13.2	2	5.3	1	2.6	38
10	30	93.8	2	6.3	0	0.0	0	0.0	32
11	30	90.9	1	3.0	2	6.1	0	0.0	33
Total	***279***	***75.8***	***42***	***11.4***	***34***	***9.2***	***13***	***3.5***	***368***
	Not Stated / Unknown								
0	0	0.0	0	0	0	0	0	0	0
1	1	100.0	0	0.0	0	0	0	0.0	1
2	5	83.3	0	0.0	0	0	1	16.7	6
3	3	100.0	0	0.0	0	0	0	0.0	3
4	4	100.0	0	0.0	0	0	0	0.0	4
5	3	75.0	0	0.0	0	0	1	25.0	4
6	4	80.0	0	0.0	0	0	1	20.0	5
7	1	50.0	1	50.0	0	0	0	0.0	2

8	1	25.0	0	0.0	0	0	3	75.0	4
9	2	100.0	0	0.0	0	0	0	0.0	2
10	3	75.0	0	0.0	0	0	1	25.0	4
11	1	50.0	0	0.0	0	0	1	50.0	2
Total	***28***	***75.7***	***1***	***2.7***	***0***	***0***	***8***	***21.6***	***37***
					Total				
0	0	0.0	0	0.0	6	100.0	0	0.0	6
1	8	33.3	0	0.0	13	54.2	1	4.2	24
2	27	79.4	2	5.9	2	5.9	3	8.8	34
3	27	73.0	2	5.4	1	2.7	2	5.4	37
4	28	60.9	6	13.0	3	6.5	1	2.2	46
5	30	62.5	9	18.8	3	6.3	3	6.3	48
6	25	61.0	11	26.8	1	2.4	3	7.3	41
7	30	61.2	10	20.4	3	6.1	3	6.1	49
8	40	80.0	1	2.0	1	2.0	4	8.0	50
9	32	76.2	5	11.9	2	4.8	2	4.8	42
10	33	89.2	2	5.4	0	0.0	1	2.7	37
11	31	86.1	1	2.8	2	5.6	1	2.8	36
Total	***307***	***68.2***	***49***	***10.9***	***37***	***8.2***	***24***	***5.3***	***450***


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