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Vaccine Preventable Diseases and Vaccination Coverage in Aboriginal and Torres Strait Islander People, Australia, 2016–2019

Joanne Jackson, Nicole Sonneveld, Harunor Rashid, Larissa Karpish, Seaneen Wallace, Lisa Whop, Cyra Patel, Julia Brotherton, Han Wang, Alexandra Hendry, Brynley Hull, Katrina Clark, Stephen Lambert, Aditi Dey, Frank Beard

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Vaccine Preventable Diseases and Vaccination Coverage in Aboriginal and Torres Strait Islander People, Australia, 2016–2019

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We respectfully acknowledge the history of dispossession and intergenerational trauma that affects the lives of many Aboriginal and Torres Strait Islander people. We recognise that the provision of culturally appropriate health care services and systems is vital to adopting a stronger commitment to self-determination by ensuring Aboriginal and Torres Strait Islander peoples have a voice regarding Aboriginal and Torres Strait Islander business and in particular to vaccine preventable diseases.

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Executive summary

Background

This report, which focuses on the 2016–2019 period, is the fifth comprehensive National Centre for Immunisation Research and Surveillance (NCIRS) report on vaccine preventable diseases (VPDs) and vaccination coverage in Aboriginal and Torres Strait Islander people. As with previous reports, it aims to analyse and assess routinely collected data on notifications, hospital admissions, deaths and vaccination coverage, to support service delivery, policy development and further research on the prevention of VPDs in Aboriginal and Torres Strait Islander people. It identifies a range of achievements, including positive impacts of immunisation programs on the health of Aboriginal and Torres Strait Islander people, and further ways to move forward.

New inclusions in this report

This report includes some analyses not presented in previous reports, as summarised below:

- an enhanced focus on completeness of Aboriginal and Torres Strait Islander status in VPD notification data, presented as a standalone chapter;
- rotavirus notification data for children aged less than 5 years for an 18-month period (1 July 2018 to 31 December 2019) after rotavirus became nationally notifiable in July 2018;
- pertussis, rotavirus and influenza notifications and hospitalisations for infants aged 0–5 months and 6–11 months, to further delineate the burden of disease in infants and impact of the pertussis and influenza vaccination during pregnancy programs; and
- adolescent and adult vaccination coverage estimates, from the expanded 'whole-of-life' Australian Immunisation Register (AIR).

Vaccination coverage

Table ES.1 summarises the National Immunisation Program schedule and vaccination coverage in 2019, by milestone age and vaccine, for Aboriginal and Torres Strait Islander people, with comparison to coverage in 2015. 'Fully vaccinated' coverage in Aboriginal and Torres Strait Islander children was higher in 2019 than in 2015 at all three age milestones (12, 24 and 60 months), although lower than in other children at 12 and 24 months of age. Coverage for all individual vaccines assessed was also higher in 2019 than in 2015. Although vaccination coverage in Aboriginal and Torres Strait Islander children is relatively high and continues to improve, timeliness of vaccination remains a concern. The percentage of Aboriginal and Torres Strait Islander children vaccinated 'on time' (within 1 month of due date) for pneumococcal (third dose), DTPa (second dose) and MMR (first dose) vaccines was 11 percentage points lower in 2019 than for other children. Strategies to improve timeliness of vaccination in Aboriginal and Torres Strait Islander children should be a key focus. The New South Wales (NSW) Health Aboriginal Immunisation Healthcare Worker Program is an example of a successful strategy in this space.

While one-dose HPV vaccination coverage in 2019 was similar in Aboriginal and Torres Strait Islander and other adolescents, course completion was 5 to 10 percentage points lower among Aboriginal and Torres Strait adolescents. Although there is emerging evidence that a single dose of HPV vaccine is highly effective, strategies are needed to optimise uptake among

Aboriginal and Torres Strait Islander adolescents of HPV and other vaccines delivered through school-based programs, including addressing the social determinants that lead to absenteeism.

The influenza and zoster vaccine coverage data presented should be regarded as minimum estimates due to likely substantial under-reporting of adult vaccinations. Completeness of reporting is anticipated to improve following the introduction of mandatory reporting in 2021.

Completeness of Aboriginal and Torres Strait Islander status in notification data

Completeness of Aboriginal and Torres Strait Islander status in notification data for selected VPDs is summarised by jurisdiction in Table ES.2. Completeness was high (over 90%) during the 2016–2019 period for most conditions across most jurisdictions, but suboptimal for influenza, pertussis and rotavirus, although with wide variations between jurisdictions. As a result, analysis of influenza notification data had to be restricted to two states and territories (the Northern Territory and Western Australia) and pertussis and rotavirus analyses to children aged < 5 years. Because of under-reporting of Aboriginal and Torres Strait Islander status, all rates presented in this report should be considered minimum estimates of the true burden of disease.

Vaccine preventable diseases

Key achievements in VPD control and ways to move forward are summarised in Table ES.3, by disease. It is also critical to acknowledge the overarching importance of addressing the range of interrelated historical, cultural, political, psychosocial and environmental factors that continue to shape the lived experience of Aboriginal and Torres Strait Islander peoples today, which contribute to the higher rates of many VPDs than in non-Indigenous people.

Table ES.1: National Immunisation Program Schedule (2019), vaccination coverage estimates (%) and percentage point change in coverage since 2015, by milestone age and vaccine, for Aboriginal and Torres Strait Islander children, adolescents and adults, Australia, 2019

Vaccine	National Immunisation Program Schedule (dose 1, dose 2, dose 3, etc.)	Milestone age for vaccination coverage	Current reporting period coverage (2019)	Percentage point change since previous reporting period (2015)
Children				
Diphtheria-tetanus- acellular pertussis	2 months, 4 months, 6 months, 18 months, 48 months	12 months (dose 3)	93.2	+3.4
		24 months (dose 4)	91.5	N/A
		60 months (dose 4 or 5)	97.4	+2.5
Polio	2 months, 4 months, 6 months, 48 months	12 months (dose 3)	93.1	+3.3
		24 months (dose 3)	97.1	+1.0
		60 months (dose 4)	97.0	+2.1
Haemophilus influenzae type b	2 months, 4 months, 6 months, 18 months	12 months (dose 3)	93.1	+4.1
		24 months (dose 4)	94.6	+0.7
Hepatitis B	Birth, 2 months, 4 months, 6 months	12 months (dose 3)	93.1	+3.4
		24 months (dose 3)	97.1	+1.1
Measles-mumps- rubella	12 months, 18 months[a]	24 months (dose 1)	96.6	N/A
		24 months (dose 2)	92.9	+3.7
		60 months (dose 2)	98.9	+3.7
Varicella	18 months[a]	24 months (dose 1)	92.7	+4.4
		60 months (dose 1)	98.8	N/A
Meningococcal C	12 months (until 2018)	24 months (dose 1)	96.6	+1.7
Meningococcal ACWY	12 months	24 months (dose 1)	95.0	N/A
13-valent pneumococcal conjugate	2 months, 4 months, 6 months, 12 months[b]	12 months (dose 2 or 3)	97.0	+7.2
		24 months (dose 3)	96.7	N/A
		30 months (dose 4)	62.0	N/A
Rotavirus	2 months, 4 months	12 months (dose 2)	87.3	+11.9
Hepatitis A[c]	12 months, 18 months	30 months (dose 2)	72.2	+1.4
Adolescents (predominantly via school programs)				
HPV	12 –< 15 years	15 years (dose 1) 15 years (dose 2)	87.8 (girls) 83.0 (boys) 77.9 (girls) 71.8 (boys)	N/A
Meningococcal ACWY	14 –< 16 years	16 years	66.1	N/A
Adults				
Herpes zoster	70 years	71 years	33.2	N/A
Influenza vaccination – all ages				
Influenza	Annual vaccination for all Aboriginal and Torres Strait Islander people aged ≥ 6 months	6 months to < 5 years 5 –< 10 years 10 –< 15 years 15 –< 20 years 20 –< 50 years 50 –< 65 years 65 –< 75 years ≥ 75 years	43.6 32.3 29.4 27.3 31.1 52.7 74.9 83.5	+31.5 N/A N/A N/A N/A N/A N/A N/A

a. MMRV vaccine given at 18 months.

b. Due to schedule changes in 2018, the coverage percent point change since 2015 of the fourth dose could not be calculated.

c. Aboriginal and Torres Strait Islander children only in the Northern Territory, Queensland, South Australia and Western Australia.

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Table ES.2: Aboriginal and Torres Strait Islander status completeness (%) in notification data for selected vaccine preventable diseases, by state/territory, Australia, 2016–2019

Vaccine preventable disease	Notifications[a]	Aboriginal and Torres Strait Islander status completeness (%)						
		Australia	Range within indicated jurisdictions[b]					
			< 20	20 –< 50	50 –< 70	70 –< 90	≥ 90	NC[c]
Haemophilus influenzae type b (Hib) disease	73	100					NSW, NT, Qld, SA, Vic., WA	ACT, Tas.
Hepatitis A	1,042	92.7				NT, Vic.	ACT, NSW, Qld, SA, Tas., WA	
Hepatitis B	612	94.6				Tas.	ACT, NSW, NT, Qld, SA, Vic., WA	
Influenza	714,488	37.4	NSW, Tas., Vic.		ACT, Qld, SA	WA	NT	
Measles	568	97.5					ACT, NSW, NT, Qld, SA, Tas., Vic., WA	
Meningococcal disease	1,120	98.4					ACT, NSW, NT, Qld, SA, Tas., Vic., WA	
Mumps	2,422	95.3				NSW, Vic.	ACT, NT, Qld, SA, Tas., WA	
Pertussis	56,963	59.2		NSW, Vic.	Qld	Tas.	ACT, NT, SA, WA	
Pneumococcal disease	7,782	91.7				NSW, Vic.	ACT, NT, Qld, SA, Tas., WA	
Rotavirus	7,911	69.7	Vic.	NSW, Tas.		Qld, SA	ACT, NT, WA	

a Notifications where date of diagnosis between 1 January 2016 and 31 December 2019, except for rotavirus (1 July 2018 to 31 December 2019).
b ACT: Australian Capital Territory; NSW: New South Wales; NT: Northern Territory; Qld: Queensland; SA: South Australia; Tas.; Tasmania; Vic.: Victoria; WA: Western Australia.
c NC: no cases in the reporting period.

Table key

≥ 90% | 70 –< 90% | 50– < 70% | 20 –< 50% | < 20% | NC

Table ES.3: Summary of key achievements and ways to move forward

Vaccine preventable disease	Key achievements	Moving forward
Diphtheria	Diphtheria is rare in Australia due to long-standing immunisation programs.	Maintain high vaccination coverage and disease surveillance.
Hepatitis A	Hepatitis A notification rates among Aboriginal and Torres Strait Islander people decreased after the immunisation program for young children was introduced in 2005, and have remained low with the all-age notification rate in the 2016–2019 period less than half that in other Australians.	Maintain vaccination coverage and disease surveillance.
Hepatitis B	Low rates of hepatitis B in people aged < 15 years, both Aboriginal and Torres Strait Islander and other, demonstrate the success of the universal infant immunisation program introduced in 2000.	Improve hepatitis B vaccination uptake in Aboriginal and Torres Strait Islander adults, either through existing jurisdictional programs or inclusion on the NIP, to address higher rates of infection and chronic sequelae.
Hib disease	Notification rates of invasive Hib disease in children aged < 5 years, both Aboriginal and Torres Strait Islander and other, have decreased by > 99% since introduction of vaccination in 1993.	Optimise timeliness of Hib vaccination in Aboriginal and Torres Strait Islander children, given notification rate in the < 5 years age group is 12 times higher than in other children, with earlier mean age of infection.
Human papillomavirus (HPV)	Rates of HPV infection, genital warts and cervical pre-cancers have decreased by 70–90% in relevant age groups, both Aboriginal and Torres Strait Islander and other, since introduction of the HPV vaccination program in 2007.	Strongly promote HPV vaccination and optimise HPV course completion among Aboriginal and Torres Strait Islander adolescents. Ensure high-quality Aboriginal and Torres Strait Islander status reporting to cervical screening and cancer registers.
Influenza	Vaccination coverage in 2019 was higher among Aboriginal and Torres Strait Islander people than other Australians, across all age groups.	Strongly promote influenza vaccination for Aboriginal and Torres Strait Islander people of all ages, and address barriers to uptake, given the high levels of morbidity and mortality associated with this disease.
Measles	Notification and hospitalisation rates in Aboriginal and Torres Strait Islander people remain low across all age groups, with the all-age notification rate half that in other Australians.	Maintain high vaccination coverage and disease surveillance.
Meningococcal disease	Routine meningococcal C vaccination, implemented from 2003, has resulted in near elimination of serogroup C disease in Australia.	Reduce barriers to uptake of meningococcal vaccination for Aboriginal and Torres Strait Islander children and adolescents, and assess need for expansion of NIP-funded programs given relatively high rates of disease.
Mumps	Coverage of measles-mumps-rubella (MMR) vaccine is very high among Aboriginal and Torres Strait Islander children (99% 2-dose coverage by 5 years of age).	Closely monitor evidence around potential need for routine MMR booster (third) doses, given recent mumps outbreaks in Aboriginal and Torres Strait Islander communities and concerns about waning of vaccine-induced immunity.
Pertussis	The notification rate in Aboriginal and Torres Strait Islander infants was 18% lower in the 2016–2019 period than the 2011–2015 period.	Improve timeliness of the first two infant doses of pertussis-containing vaccine, and uptake of maternal pertussis vaccination during pregnancy, to protect Aboriginal and Torres Strait Islander infants, who are at high risk of severe pertussis.
Pneumococcal disease	Invasive pneumococcal disease (IPD) notification rates in Aboriginal and Torres Strait Islander children and adolescents were 23% lower in children aged < 5 years in the 2016–2019 period than the 2011–2015 period, and 60% lower in those aged 5–14 years. Coverage of 13-valent pneumococcal conjugate vaccine (13vPCV) was high among Aboriginal and Torres Strait Islander children (97% for dose 3, assessed at 24 months), resulting in a decline in rates of IPD caused by the additional six serotypes covered by 13vPCV compared to the previous 7-valent vaccine.	Promote high uptake of pneumococcal vaccination among Aboriginal and Torres Strait Islander adults aged ≥ 50 years, and younger individuals with underlying medical conditions, given increasing IPD notification rates. Monitor IPD epidemiology in Aboriginal and Torres Strait Islander people to identify any need for expanded access to NIP-funded vaccines, both current and newer higher valency ones.

Vaccine preventable disease	Key achievements	Moving forward
Polio	Australia was declared free of endemic polio transmission by WHO in 2000; there were no notifications of polio in the 2016–2019 period.	Maintain high vaccination coverage and disease surveillance.
Rotavirus	Rotavirus hospitalisation rates in Aboriginal and Torres Strait Islander infants have decreased by approximately 80% since the national rotavirus immunisation program was introduced in 2007.	Optimise timeliness of vaccination in Aboriginal and Torres Strait Islander infants, who are at high risk of severe disease. Consider other potential strategies such as loosening of current strict upper age limits for rotavirus vaccines.
Rubella	Rubella was declared eliminated from Australia by WHO in 2018; there were < 5 notifications among Aboriginal and Torres Strait Islander people in the 2016–2019 period.	Maintain high vaccination coverage and disease surveillance.
Tetanus	Tetanus is rare in Australia due to long-standing immunisation programs.	Maintain high vaccination coverage and disease surveillance.
Varicella (chickenpox)	The all-age varicella hospitalisation rate in Aboriginal and Torres Strait Islander people has decreased by 67% since the national varicella immunisation program was introduced in 2005. The varicella hospitalisation rate among Aboriginal and Torres Strait Islander children aged < 5 years was 53% lower in the 2016–2019 period than the 2011–2015 period.	Maintain high vaccination coverage and disease surveillance.
Zoster (shingles)	Zoster hospitalisation rates in Aboriginal and Torres Strait Islander people, which were rising prior to introduction of the national zoster vaccination program in 2016, have since plateaued and, more recently, may have started to decrease.	Increase zoster vaccination coverage. Monitor disease rates to identify any need for expanded access to NIP-funded vaccines, both current live vaccine and newer inactivated vaccine.

Abbreviations

Abbreviations	Definition
2vHPV	Bivalent HPV vaccine
4vHPV	Quadrivalent human papillomavirus vaccine
7vPCV	7-valent pneumococcal conjugate vaccine
9vHPV	Nonavalent human papillomavirus vaccine
13vPCV	13-valent pneumococcal conjugate vaccine
23vPPV	23-valent pneumococcal polysaccharide vaccine
ABS	Australian Bureau of Statistics
ACR	Australian Coordinating Registry
ACT	Australian Capital Territory
AIHW	Australian Institute of Health and Welfare
AIR	Australian Immunisation Register
APSU	Australian Paediatric Surveillance Unit
BCG	Bacillus Calmette–Guérin
CI	Confidence interval
CIN	Cervical intraepithelial neoplasia
CRS	Congenital rubella syndrome
DNA	Deoxyribonucleic acid
DTPa	Diphtheria-tetanus-pertussis vaccine
dTpa	Diphtheria-tetanus-pertussis vaccine (reduced antigen formulation)
HAV	Hepatitis A virus
HBV	Hepatitis B virus
Hib	*Haemophilus influenzae* type b
Hib-MenC	*Haemophilus influenzae* type b- meningococcal serogroup C vaccine
HPV	Human papillomavirus
HZ	Herpes zoster
ICD	International Classification of Diseases
ICD-10-AM	*International Statistical Classification of Diseases and Related Health Problems*, 10th Revision, Australian Modification
IMD	Invasive meningococcal disease
IPD	Invasive pneumococcal disease
MenACWY	Quadrivalent meningococcal conjugate vaccine
NCIRS	National Centre for Immunisation Research and Surveillance
NIP	National Immunisation Program
NNDSS	National Notifiable Diseases Surveillance System
NSW	New South Wales
NT	Northern Territory
PCR	Polymerase chain reaction
Qld	Queensland
RR	Rate ratio
SA	South Australia
Tas.	Tasmania
Vic.	Victoria
VPD	Vaccine preventable disease
VZV	Varicella-zoster virus
WA	Western Australia
WHO	World Health Organization

Introduction

This is the fifth report on vaccine preventable diseases (VPDs) and vaccination coverage in Aboriginal and Torres Strait Islander people. The first (1999–2002) was published in 2004, the second (2003–2006) in 2008, the third (2006–2010) in 2013 and the fourth (2011–2015) in 2019.[1–4]

Notification (from the National Notifiable Diseases Surveillance System), hospital admission (from the Australian Institute of Health and Welfare National Hospital Morbidity Database) and death (from the Australian Coordinating Registry) data are presented for all jurisdictions for the 2016–2019 period. Notification trends are reported for all jurisdictions for the 2010–2019 period, and hospitalisation trends are reported for six jurisdictions (all except Tasmania and the Australian Capital Territory, which did not meet AIHW reporting standards)[5,6] for the 2010–2019 period. National vaccination coverage data were obtained from the Australian Immunisation Register (AIR). For all datasets, records with unknown or missing Aboriginal and Torres Strait Islander status were combined with those identified as non-Indigenous and reported under the category 'other'. The term 'non-Indigenous' is only used in this report when referring to findings of other publications which specifically report data in people identified as non-Indigenous. Refer to Appendix A for more detail on data sources and methods and to Appendix B for the International Classification of Diseases codes used for hospitalisation and death data.

This report provides comprehensive and detailed data on disease burden and vaccination coverage in Aboriginal and Torres Strait Islander people and other Australians, and also includes an enhanced focus on completeness of Aboriginal and Torres Strait Islander status reporting in VPD notification data.

Diseases responsible for a substantial burden of illness in Aboriginal and Torres Strait Islander people are presented in individual chapters, and diseases that are now rare due to long-standing successful immunisation programs are presented in a combined chapter. Data are provided for all diseases and vaccines included in the National Immunisation Program (NIP) for the period of analysis. Due to differences in the sources of routinely collected data on HPV disease impact, it is reported in a different format. Tuberculosis is not included in this or other reports in this series, as control of tuberculosis in Australia is primarily underpinned by effective diagnosis and treatment, with limited use of Bacille Calmette-Guérin (BCG) vaccine. Data on tuberculosis, including in Aboriginal and Torres Strait Islander people, are published elsewhere.[7]

An understanding of the demographics of the Aboriginal and Torres Strait Islander population is important to interpret the data in this report. As of 2016, there were an estimated 798,365 Aboriginal and Torres Strait Islander people in Australia (3.3% of the total Australian population).[8] In 2016, 33% of the Aboriginal and Torres Strait Islander population were estimated to live in New South Wales, 28% in Queensland, 13% in Western Australia, 9% in the Northern Territory, 7% in Victoria, 5% in South Australia, 4% in Tasmania and 1% in the Australian Capital Territory. A higher proportion of Aboriginal and Torres Strait Islander people live in remote areas compared to non-Indigenous Australians – an estimated 19% and 2%, respectively, in 2016.[8] The Aboriginal and Torres Strait Islander population has a younger age structure than the non-Indigenous population, with respective median ages of 23 years and 38 years in 2016, and a higher level of socioeconomic disadvantage across a range of indices.[8]

Risk factors often associated with the burden of VPDs among Aboriginal and Torres Strait Islander people, such as smoking and overcrowded housing, are mentioned in various places in this report. However, it is important to note that these risk factors are downstream indicators secondary to a range of inter-related historical, cultural, political, psychosocial and

environmental factors.[9–11] The authors respectfully acknowledge the history of colonisation, dispossession, inter-generational trauma and other dehumanising policies that continue to shape the lived experience of Aboriginal and Torres Strait Islander peoples today, and which contribute to the higher rates of many VPDs, compared with non-Indigenous people.[9,11]

The aim of this report is to present recent data from routinely collected sources, along with informed commentary, to facilitate culturally appropriate and effective service delivery, policy development and further research to better prevent VPDs in Aboriginal and Torres Strait Islander people. The primary audiences for this report are professionals and students in the health sector, government and academic institutions, but the aim is for the report to be accessible to all those with an interest in improving the health of Aboriginal and Torres Strait Islander people.

1. Aboriginal and Torres Strait Islander status completeness for vaccine preventable diseases in notification data, Australia, 2016–2019

The quality of Aboriginal and Torres Strait Islander health statistics depends on the accuracy of Aboriginal and Torres Strait Islander population estimates, and on the level of completeness and accuracy of Aboriginal and Torres Strait Islander status reporting in the data set of interest. Surveillance of vaccine preventable diseases in Aboriginal and Torres Strait Islander people within this report uses three sources of routinely collected data: notification data obtained from the National Notifiable Diseases Surveillance System (NNDSS); hospitalisation data obtained from the Australian Institute of Health and Welfare (AIHW) National Hospital Morbidity Database; and mortality data provided by the Australian Coordinating Registry (ACR). Whilst the AIHW and ABS have released reports on the quality of Aboriginal and Torres Strait Islander identification in hospitalisation and mortality data, respectively, with recommendations for reporting by Aboriginal and Torres Strait Islander status,[12,13] similar reports are not available for notification data.

Accurate estimation of vaccine preventable disease notification rates by Aboriginal and Torres Strait Islander status is critical to inform health policy, program and service delivery for Aboriginal and Torres Strait Islander peoples, and to evaluate the effectiveness of these interventions.

This report includes an enhanced focus on completeness of Aboriginal and Torres Strait Islander status in vaccine preventable disease notification data, by disease and state/territory for the period 2016 to 2019, and on trends since the previous report.

Methods used for assessment of Aboriginal and Torres Strait Islander status completeness

All notified cases of diphtheria, *Haemophilus influenzae* type b (Hib) disease, hepatitis A, hepatitis B (newly acquired infection within last 2 years), laboratory confirmed influenza, measles, meningococcal disease, mumps, pertussis, pneumococcal disease, rubella and tetanus, with a diagnosis date between 1 January 2016 and 31 December 2019, and notified rotavirus cases with a diagnosis date between 1 July 2018 and 31 December 2019 (nationally notifiable from 1 July 2018) were extracted from NDDSS on 1 February 2021. Aboriginal and Torres Strait Islander status completeness was not assessed for human papillomavirus (HPV) infection/disease (as not notifiable to NNDSS but reported through cervical screening systems),[14] for varicella-zoster virus (due to the high proportion of notifications that are coded as non-specific for varicella or zoster), or for poliomyelitis (no notifications reported between 2016 and 2019). The NNDSS dataset extracted for the previous report,[1] i.e. notified cases of the same conditions (excepting rotavirus) with a diagnosis date between 1 January 2011 and 31 December 2015, was used to assess trends in completeness.

Variables extracted from NNDSS were: notification ID, disease code, diagnosis date, age at onset, state/territory and Indigenous status ('Indigenous' [Aboriginal, Torres Strait Islander, or Aboriginal and Torres Strait Islander], 'not Indigenous' and 'unknown' [not stated, blank or missing]). Aboriginal and Torres Strait Islander status is classified in this report as 'Aboriginal and Torres Strait Islander' (individuals recorded as Indigenous in NNDSS) and 'other' (individuals recorded as 'not Indigenous' or 'unknown').

Table 1: Aboriginal and Torres Strait Islander status completeness (%) in notification data for selected vaccine preventable diseases, by state/territory, Australia, 2016–2019[a]

Vaccine preventable disease	Notifications[a]	Aboriginal and Torres Strait Islander status completeness (%)[b,c]								
		ACT	NSW	NT	Qld	SA	Tas.	Vic.	WA	Australia
Diphtheria	34	NC	≥ 90	≥ 90	≥ 90	≥ 90	NC	≥ 90	≥ 90	94.1
Haemophilus influenzae type b (Hib) disease	73	NC	≥ 90	≥ 90	≥ 90	≥ 90	NC	≥ 90	≥ 90	100
Hepatitis A	1,042	≥ 90	≥ 90	70 –< 90	≥ 90	≥ 90	≥ 90	70 –< 90	≥ 90	92.7
Hepatitis B	612	≥ 90	≥ 90	≥ 90	≥ 90	≥ 90	70 –< 90	≥ 90	≥ 90	94.6
Influenza	714,488	50 –< 70	< 20	≥ 90	50 –< 70	50 –< 70	< 20	< 20	70 –< 90	37.4
Measles	568	≥ 90	≥ 90	≥ 90	≥ 90	≥ 90	≥ 90	≥ 90	≥ 90	97.5
Meningococcal disease	1,120	≥ 90	≥ 90	≥ 90	≥ 90	≥ 90	≥ 90	≥ 90	≥ 90	98.4
Mumps	2,422	≥ 90	70 –< 90	≥ 90	≥ 90	≥ 90	≥ 90	70–<90	≥ 90	95.3
Pertussis	56,963	≥ 90	20 –< 50	≥ 90	50 –< 70	≥ 90	70 –< 90	20 –< 50	≥ 90	59.2
Pneumococcal disease	7,782	≥ 90	70 –< 90	≥ 90	≥ 90	≥ 90	≥ 90	70–<90	≥ 90	91.7
Rotavirus	7,911	≥ 90	20 –< 50	≥ 90	70 –< 90	70 –< 90	20 –< 50	< 20	≥ 90	69.7
Rubella	58	NC	≥ 90	NC	≥ 90	NC	≥ 90	50 –< 70	≥ 90	84.5
Tetanus	17	NC	≥ 90	NC	≥ 90	≥ 90	NC	≥ 90	≥ 90	100

a Notifications where date of diagnosis between 1 January 2016 and 31 December 2019, except for rotavirus (1 July 2018 to 31 December 2019).
b ACT: Australian Capital Territory; NSW: New South Wales; NT: Northern Territory; Qld: Queensland; SA: South Australia; Tas.; Tasmania; Vic.: Victoria; WA: Western Australia.
c NC: no cases in the reporting period.

Table key

≥ 90% | 70 –< 90% | 50– < 70% | 20 –< 50% | < 20%

Table 2: Aboriginal and Torres Strait Islander status completeness (%) in notification data for influenza, pertussis and rotavirus, by age group, Australia, 2016–2019[a]

Vaccine preventable disease	Aboriginal and Torres Strait Islander status completeness				
	Age group (years)				
	0–4	5–14	15–24	25–49	50+
Influenza	40.6%	38.5%	42.5%	34.2%	36.7%
Pertussis	92.6%	58.7%	52.6%	48.8%	50.8%
Rotavirus	79.2%	70.5%	58.5%	54.2%	62.3%

a Notifications where date of diagnosis between 1 January 2016 and 31 December 2019, except for rotavirus (1 July 2018 to 31 December 2019).

Completeness was calculated by dividing the number of notifications with a known Aboriginal and Torres Strait Islander status ('Indigenous' and 'not Indigenous') by the total number of notifications. Completeness is presented for each disease by state/territory, categorised as < 20%; 20 to < 50%; 50 to < 70%; 70 to < 90%; or 90 to 100%, and by age group for diseases with overall completeness less than 70%.

Results of Aboriginal and Torres Strait Islander status completeness assessment

Completeness in 2016 to 2019 period

In the 2016 to 2019 period, Aboriginal and Torres Strait Islander status completeness was over 90% at the national level for notifications of diphtheria (94.1%), Hib disease (100%), hepatitis A (92.7%), newly acquired hepatitis B (94.6%), measles (97.5%), meningococcal disease (98.4%), mumps (95.3%), pneumococcal disease (91.7%) and tetanus (100%) (Table 1). At a jurisdictional level, completeness for hepatitis A, hepatitis B, mumps and pneumococcal disease notifications was over 90% in the majority of states and territories, and between 70% and 90% in one or two jurisdictions. Completeness for rubella was 84.5% at the national level, and over 90% in four of the five states with notifications over the study period (New South Wales, Queensland, Tasmania and Western Australia) and between 50% and 70% in Victoria (which had 16 notifications over the period).

Aboriginal and Torres Strait Islander status completeness was less than 70% at the national level for laboratory-confirmed influenza (37.4%), pertussis (59.2%) and rotavirus (69.7%) notifications, with substantial variability across states and territories. Completeness was over 90% for rotavirus notifications in the Australian Capital Territory, the Northern Territory and Western Australia; for pertussis notifications in the Australian Capital Territory, the Northern Territory, South Australia and Western Australia; but for influenza notifications in the Northern Territory only.

For influenza notifications, Aboriginal and Torres Strait Islander status completeness was less than 50% across all age groups at the national level, ranging from 34.2% for 25–49 year olds to 42.5% among 15–24 year olds (Table 2). For pertussis notifications, completeness at the national level among children aged less than 5 years was 92.6% (over 70% in all states and territories) and between 49% and 59% for other age groups. For rotavirus notifications, completeness at the national level among children aged less than 5 years was 79.2% (over 70% in all states and territories except Victoria and New South Wales) and between 54% and 71% in older age groups.

Trends in completeness

Aboriginal and Torres Strait Islander status completeness in the 2016 to 2019 period was broadly similar to the 2011 to 2015 period for

Hib disease (100% vs 98.8%), hepatitis A (92.7% vs 96.3%), measles (97.5% vs 94.6%), meningococcal disease (98.4% vs 96.8%), pneumococcal disease (invasive) (91.7% vs 89.4%), hepatitis B (94.6% vs 89.0%), rubella (84.5% vs 88.1%), pertussis (59.2% vs 53.6%) and influenza (37.4% vs 40.8%). Completeness improved in the 2016 to 2019 period from the 2011 to 2015 period for mumps (95.3% vs 83.9%), diphtheria (94.1% vs 81.2%) and tetanus (100% vs 84.2%). Rotavirus was not nationally notifiable until mid-2018.

Inclusion of data in this report based on completeness

Based on the data presented above, we set 70% completeness of Aboriginal and Torres Strait Islander status as the minimum acceptable level for inclusion of notification data in this report. For diphtheria, Hib disease, hepatitis A, hepatitis B, measles, meningococcal disease, mumps, pneumococcal disease, rubella and tetanus, we included data from all states and territories. For influenza we included data from the Northern Territory and Western Australia only, while for pertussis we included data for children aged less than 5 years from all states and territories and for rotavirus we included data for children aged less than 5 years from the Australian Capital Territory, the Northern Territory, Queensland, South Australia, Tasmania and Western Australia only.

Discussion of Aboriginal and Torres Strait Islander status completeness issues

Selection of an acceptable level of Aboriginal and Torres Strait Islander status completeness for inclusion in reports on NNDSS data is not straightforward, with the Kirby Institute and AIHW having previously used a minimum level of 50% completeness for inclusion of state/territory data,[15,16] lower than we use in this report. The more incomplete Aboriginal and Torres Strait Islander status is, the more likely analyses are to underestimate the incidence of Aboriginal and Torres Strait Islander peoples. However, the exclusion of states and territories with inadequate completeness of Aboriginal and Torres Strait Islander status can also introduce bias into national estimates, as true incidence may differ between included and excluded jurisdictions.[17] A high level of completeness for all diseases and across all jurisdictions should therefore be the ultimate goal to optimise the accuracy and usefulness of notification data.

The quality and completeness of Aboriginal and Torres Strait Islander status in NNDSS data is influenced by mechanisms of reporting and follow-up which vary between diseases.[18] Most notifications originate from pathology laboratories, and may lack Aboriginal and Torres Strait Islander status due to absence of the relevant field on pathology forms or to issues with completion and transfer of the data from referring medical practitioners.[19] Follow-up by public health units, with the treating medical practitioner and/or the case themselves, can result in completion of information that was initially missing, including Aboriginal and Torres Strait Islander status. Completeness of Aboriginal and Torres Strait Islander status in this reporting period was over 90% at national level for diphtheria, Hib disease, hepatitis A, acute hepatitis B, measles, meningococcal disease, pneumococcal disease and tetanus notifications, which are usually followed up by public health units.[20–27] However it was 70% for rotavirus, 59% for pertussis and 37% for influenza, which are all common diseases with public health unit follow-up of laboratory notifications being either very limited (rotavirus and influenza)[28,29] or prioritised (to people who may pose a transmission risk to infants < 6 months of age in the case of pertussis).[30] The marked increase in completeness for mumps notifications, which are not routinely followed up by many public health units,[31] could reflect increased follow-up related to the prolonged outbreaks in Aboriginal peoples in Western Australia between 2015 and 2016 and in Queensland between 2017 and 2018.[32,33]

Other reasons for poor quality or incomplete Aboriginal and Torres Strait Islander status in health data include limited understanding and training of health staff in processes and importance of data collection, and assumptions made

about Aboriginal and Torres Strait Islander identification based on an individual's appearance or name.[19,34–36] Data linkage has been used to improve the quality and completeness of Aboriginal and Torres Strait Islander identification in health data, with national best practice guidelines published in 2012.[37,38] The high completeness of Aboriginal and Torres Strait Islander status for influenza and rotavirus notifications in the Northern Territory and Western Australia may reflect such data linkage activities. Following on from this report, we plan to undertake further analysis to explore variations in completeness of Aboriginal and Torres Strait Islander status in vaccine preventable disease notification data, including by geographic remoteness. We also intend to conduct in-depth interviews of key stakeholders to identify successful state and territory initiatives in this space and to disseminate examples of best practice for optimising the completeness and quality of vaccine preventable disease notification data.

2. *Haemophilus influenzae* type b disease

Relevant vaccine history

1993
- Hib vaccine recommended in childhood vaccination schedule for all children
- PRP-OMP-containing vaccines,[i] providing protection at an earlier age than other vaccines, used for Aboriginal and Torres Strait Islander children

2009
- Combined DTPa-HepB-IPV-Hib (PRP-T)[ii] vaccine at 2, 4, 6 and 12 months of age used in all jurisdictions

2013
- Combined Hib (PRP-T) and meningococcal C vaccine funded as booster dose for infants aged 12 months

2017
- PRP-OMP-containing vaccine ceased to be available in Australia

2018
- Combined Hib (PRP-T) and meningococcal C vaccine used in infants at age 12 months replaced with monovalent Hib (PRP-T) vaccine for children aged 18 months

Haemophilus influenzae is a gram-negative coccobacillus which can cause infection at various body sites. Serotype b of *Haemophilus influenzae* (Hib) is the leading cause of serious *Haemophilus* disease, particularly in childhood.[39] Hib can cause diseases of the respiratory tract, including otitis media, sinusitis and bronchitis. Serious manifestations of Hib disease include meningitis, bacteraemia, epiglottitis, septic arthritis, pericarditis, osteomyelitis, soft tissue abscesses and cellulitis.[40] Before Hib vaccines became available, Hib was the most common serious bacterial infection in young children in Australia,[41] with up to 70% of bacterial meningitis in children attributable to Hib.[42] During the prevaccine era, Aboriginal and Torres Strait Islander children had a particularly high incidence of Hib meningitis, among the highest recorded in the world, and with a significantly younger age of onset than that for non-Indigenous children.[42]

Results

Notification data for invasive Hib disease are presented for all jurisdictions for the 2016–2019 period. No hospitalisation or mortality data are presented for invasive Hib disease because the available ICD-10-AM/ICD-10 codes are not type-specific.

A total of 73 notifications of invasive Hib disease were recorded during this reporting period, of which 22 (30.1%) were reported in Aboriginal and Torres Strait Islander people. The highest age-specific notification rate was seen in Aboriginal and Torres Strait Islander children aged < 5 years (3.7 per 100,000 population per year; Table 3). No cases were recorded in Aboriginal and Torres Strait Islander people aged 15–24 years. Aboriginal and Torres Strait Islander status was reported for all of the 73 notifications during the 2016–2019 period.

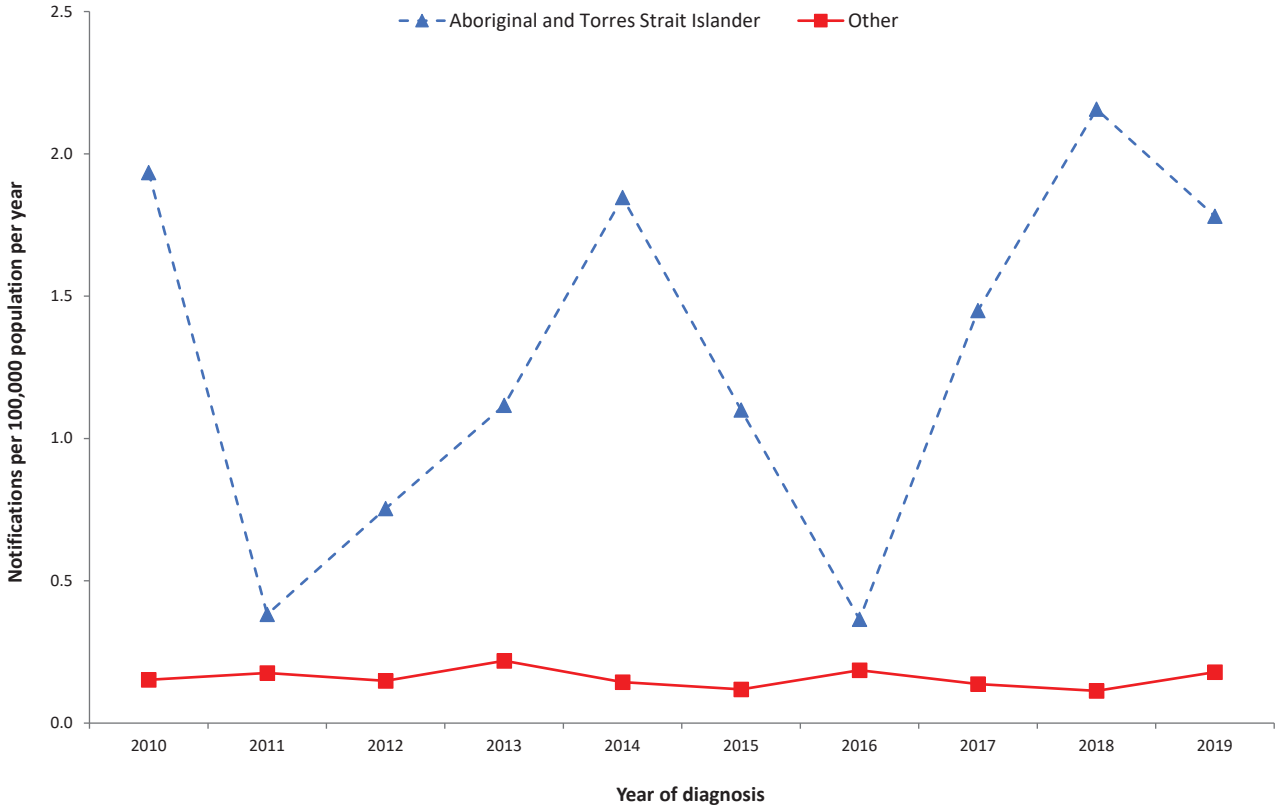
The overall (all ages) notification rate ratio (RR) for Aboriginal and Torres Strait Islander people versus others was 10.9 (95% confidence interval [95% CI]: 5.9–18.3), with the age-specific notification rate ratio highest in the ≥ 50, 25–49 and 0–4 years age groups (Table 3).

Hib notification trends in Australia over the decade 2010–2019 are shown for children aged <15 years in Figure 1. Notification rates in Aboriginal and Torres Strait Islander children were higher in all years (range 0.4 to 2.2 per 100,000 population) with marked fluctuation due to small numbers, while notification rates in other children remained low (0.1 to 0.2) and stable.

i PRP-OMP: Hib polysaccharide conjugated to the outer membrane protein of *Neisseria meningitidis*.

ii PRP-T: Hib polysaccharide conjugated to tetanus toxoid

Figure 1: Hib notification rates, Australia (all states and territories), 2010–2019,[a] < 15 years of age, by Aboriginal and Torres Strait Islander status



a Notifications where the date of diagnosis was between 1 January 2010 and 31 December 2019.

Table 3: Hib notifications in Australia (all states and territories), 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Notifications (2016–2019)[a]			
		N	Rate[b]	Rate ratio	95% CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	14	3.71	11.5	5.4–24.3
	Other	19	0.32		
5–14	Aboriginal and Torres Strait Islander	2	0.27	4.0	0.4–19.9
	Other	8	0.07		
15–24	Aboriginal and Torres Strait Islander	0	0.00	0.0	0.0–749.1
	Other	1	0.01		
25–49	Aboriginal and Torres Strait Islander	2	0.20	13.3	1.3–81.1
	Other	5	0.01		
≥ 50	Aboriginal and Torres Strait Islander	4	0.75	13.6	3.3–41.2
	Other	18	0.06		
All ages[c]	Aboriginal and Torres Strait Islander	22	0.59	10.9	5.9–18.3
	Other	51	0.05		

a Notifications where the date of diagnosis was between 1 January 2016 and 31 December 2019.

b Average annual age-specific rate per 100,000 population.

c Rates for all ages combined are age-standardised to the Australian Bureau of Statistics Australian population estimates for 2016.

Discussion

Hib disease notification rates have decreased significantly since the introduction of vaccines in 1993, but have remained relatively stable in recent years. In studies from the pre-immunisation period (1984–1993), the notification rate for Aboriginal and Torres Strait Islander children aged < 5 years was as high as 500 per 100,000 per year, around tenfold higher than the reported incidence of 40–90 per 100,000 per year for non-Indigenous children.[43] In this reporting period (2016–2019), more than 20 years after the introduction of Hib vaccines, the notification rate for Aboriginal and Torres Strait Islander children in the 0–4 years age group was 3.7 per 100,000 per year, and for other children 0.3 per 100,000 per year, representing a reduction of more than 99% for both groups compared to that in the pre-immunisation period. However, while the incidence of invasive Hib disease is now very low, rates in Aboriginal and Torres Strait Islander children aged < 5 years remain around 12 times higher than those in other children.

In 2009, global shortages of PRP-OMP vaccine necessitated a transition to the PRP-T vaccine for all Australians.[44] This included Aboriginal and Torres Strait Islander children living in jurisdictions with the highest pre-vaccine incidence of Hib disease (i.e., the Northern Territory, Queensland, South Australia, Victoria and Western Australia) where PRP-OMP vaccine had previously been used due to its ability to provide early immunogenicity from the age of two months.[45] A previous report analysing data to 2013 found no increase in Hib disease in Aboriginal and Torres Strait Islander children in the four years following the replacement of PRP-OMP vaccine by PRP-T,[46] with data until the end of 2015 corroborating this finding[1] and data in this reporting period (until the end of 2019) remaining largely unchanged.

Data from Indigenous populations worldwide have similarly shown both dramatic decreases in invasive Hib disease and a residual incidence which remains substantially higher than that in corresponding non-Indigenous populations.[47] Social and environmental factors that contribute to this situation include household crowding, high smoking rates and lack of access to culturally appropriate health services, all of which are secondary to a long history of colonisation, dispossession and disadvantage common to Indigenous populations in developed countries.[48] Studies have shown that Hib nasopharyngeal carriage continues in Aboriginal and Torres Strait Islander children despite high vaccination coverage.[48] It has also been suggested that some Indigenous populations have an increased susceptibility to Hib disease as well as poor immune responses to vaccination.[48] Genetic factors have been implicated in some settings,[47] but a study comparing remote dwelling Aboriginal and Torres Strait Islander children with urban dwelling non-Indigenous children found lower immune responses to PRP-OMP vaccine only after the first year of life, consistent with environmental rather than genetic factors.[49]

Hib vaccination coverage among Aboriginal and Torres Strait Islander children in 2019 was slightly lower than in other children at 12 months (93.1% versus 95.0%) but higher when measured at 24 months (94.6% versus 94.1%) and 60 months (98.9% versus 96.4%; refer to Vaccination Coverage section). Addressing logistical and accessibility issues that affect timeliness of vaccination is particularly important in relation to Hib, as the median age of disease onset continues to be significantly lower in Aboriginal and Torres Strait Islander people in the post-vaccine era (14 months versus 14 years).[50]

3. Hepatitis A

Relevant vaccine history

1994
- First hepatitis A vaccine registered for use in adults

1999
- Funded hepatitis A vaccine commenced for Aboriginal and Torres Strait Islander children 18 months to 6 years of age living in North Queensland

2000
- List of at-risk individuals for whom hepatitis A vaccination is recommended expanded to include visitors to remote Aboriginal and Torres Strait Islander communities

2005
- Hepatitis A vaccination (2 doses) recommended and funded for Aboriginal and Torres Strait Islander children 12 and 18 months of age residing in the Northern Territory and Western Australia, and 18 and 24 months of age for children residing in Queensland and South Australia

2013
- Hepatitis A vaccination (2 doses) scheduled ages for Aboriginal and Torres Strait Islander children in Queensland and South Australia lowered to 12 and 18 months

2018
- Hepatitis A vaccination funded for men who have sex with men in Victoria and Tasmania, and also in Victoria for individuals who have injected drugs in the past 12 months.

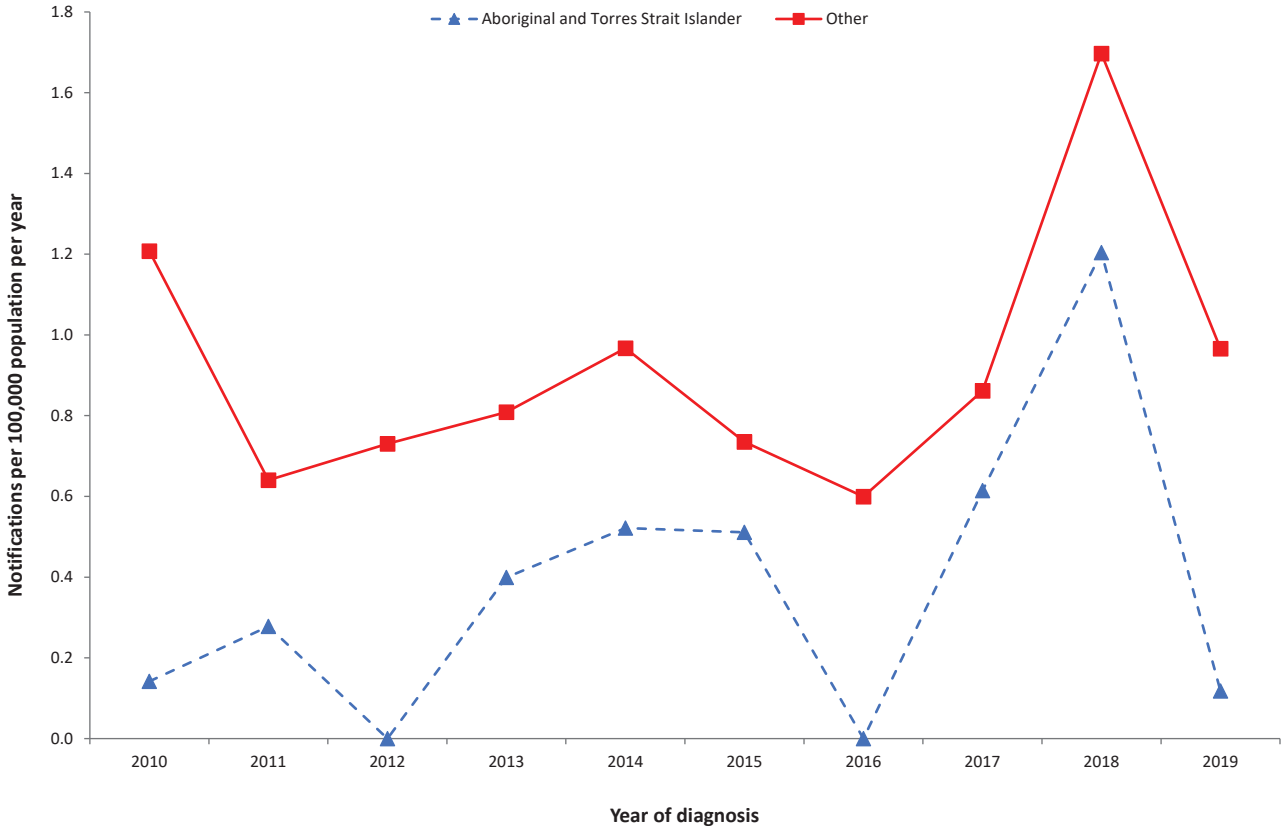
Hepatitis A is an acute infection of the liver caused by the hepatitis A virus (HAV), a picornavirus. HAV transmission occurs via the faecal-oral route, either by direct contact with an infectious person, or by ingestion of contaminated food or water. Symptoms of hepatitis A are similar to those of other forms of viral hepatitis and include fatigue, malaise, abdominal pain, nausea and vomiting. Typical clinical features of hepatitis A include jaundice, dark urine and pale-coloured stools.[51] The likelihood of symptomatic hepatitis A infection increases with age. Infants and children infected with hepatitis A virus usually have mild or no symptoms, while the majority of adults will experience symptoms.[51] The greatest burden of hepatitis A is in lower- and middle-income countries.[52,53] In recent years, most cases of hepatitis A in Australia have been associated with travel to endemic countries, foodborne outbreaks and among men who have sex with men.[54–58]

Results

Hepatitis A notification data by age and Aboriginal and Torres Strait Islander status for all states and territories for the 2016–2019 period are shown in Table 4. A total of 1,042 notifications was recorded during this period, including 16 notifications (1.5%) reported in Aboriginal and Torres Strait Islander people. There were no notifications in Aboriginal and Torres Strait Islander children aged 0–4 years.

Notification rates in Aboriginal and Torres Strait Islander people were lower than those in other people across all age groups. However, the difference was only statistically significant for age groups < 5 years and for all ages combined (Aboriginal and Torres Strait Islander to other notification rate ratios 0.0 [95% CI: 0.0–0.8] and 0.4 [95% CI: 0.2–0.7], respectively). The highest age-specific notification rate in Aboriginal and Torres Strait Islander people was 0.7 per 100,000 population per year in the 25–49 years age group, while the highest rate in other people was 1.5 per 100,000 population per year in the 15–24 years age group.

Figure 2: Hepatitis A notification rates, Australia (all states and territories), 2010–2019,[a] by Aboriginal and Torres Strait Islander status



a Notifications where the date of diagnosis was between 1 January 2010 and 31 December 2019.

Table 4: Hepatitis A notifications, Australia (all states and territories), 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Notifications[a] (2016–2019)			
		N	Rate[b]	Rate ratio	95% CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	0	0.00	0.0	0.0–0.8
	Other	70	1.18		
5–14	Aboriginal and Torres Strait Islander	4	0.55	0.5	0.1–1.2
	Other	141	1.21		
15–24	Aboriginal and Torres Strait Islander	4	0.63	0.4	0.1–1.1
	Other	184	1.50		
25–49	Aboriginal and Torres Strait Islander	7	0.69	0.5	0.2–1.0
	Other	477	1.42		
50+	Aboriginal and Torres Strait Islander	1	0.19	0.4	0.0–2.2
	Other	154	0.47		
All ages[c]	Aboriginal and Torres Strait Islander	16	0.45	0.4	0.2–0.7
	Other	1,026	1.08		

a Notifications where the date of diagnosis was between 1 January 2016 and 31 December 2019.

b Average annual age-specific rate per 100,000 population.

c Rates for all ages combined are age-standardised in standard population following the ABS Australian population estimates for 2016.

Table 5: Hepatitis A hospitalisations, Australia (all states and territories), 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Hospitalisations[a] (2016–2019)			
		N	Rate[b]	Rate ratio	95%CI for Rate Ratio
0–4	Aboriginal and Torres Strait Islander	0	0.00	0.0	0.0–4.1
	Other	16	0.31		
5–14	Aboriginal and Torres Strait Islander	5	0.78	1.5	0.5–3.8
	Other	52	0.51		
15–24	Aboriginal and Torres Strait Islander	7	1.26	1.1	0.4–2.4
	Other	119	1.11		
25–49	Aboriginal and Torres Strait Islander	23	2.61	1.6	1.0–2.5
	Other	465	1.59		
50+	Aboriginal and Torres Strait Islander	11	2.39	1.1	0.5–1.9
	Other	637	2.25		
All ages[c]	Aboriginal and Torres Strait Islander	46	1.96	1.3	0.9–1.6
	Other	1,289	1.53		

a Hospital admissions where hepatitis A is listed as the principal or other additional diagnosis and where the date of admission was between 1 January 2016 and 30 June 2019. 2019 hospitalisation data were annualised.

b Average annual age-specific rate per 100,000 population.

c Rates for all ages combined are age-standardised to the ABS Australian population estimates for 2016.

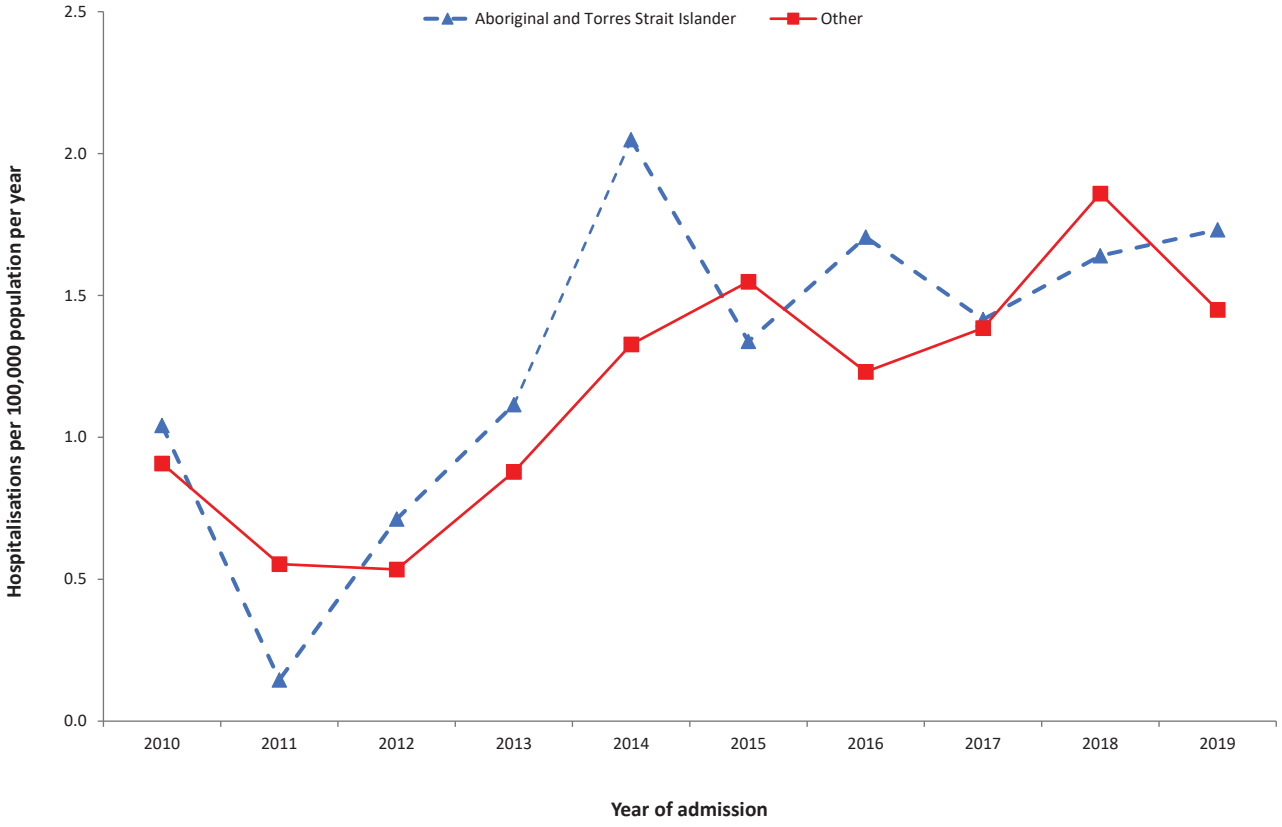
Trends in hepatitis A notification rates in Australia for the period 2010 to 2019 are shown in Figure 2. Notification rates were consistently lower in Aboriginal and Torres Strait Islander than in other people over the 10-year period. Notification rates peaked in 2018 for both Aboriginal and Torres Strait Islander and other people (1.2 and 1.7 per 100,000 population, respectively).

Hospitalisation data for all jurisdictions for the 2016–2019 period are shown in Table 5. Of the total 1,335 hospitalisations recorded, 46 (3.4%) were reported in Aboriginal and Torres Strait Islander people. Hospitalisation rates were higher in Aboriginal and Torres Strait Islander people than in other Australians in all age groups ≥ 5 years. However, the difference in rates was not statistically significant in any age group or for all ages combined. Trends in hospitalisation rates are presented for six states and territories (excluding the Australian Capital Territory and Tasmania) for the 2010–2019 period (Figure 3). Rates were higher over the 2015–2019 period than in the 2010–2014 period, for both Aboriginal and Torres Strait Islander people and other Australians.

There were 11 deaths reported with hepatitis A recorded as the underlying or associated cause of death for the 2016–2019 period in Australia. Of these deaths, 1–5[i] were reported as having occurred in people identified as Aboriginal or Torres Strait Islander.

i To comply with the Australian Coordinating Registry's data release condition that death counts <6 be suppressed in published reports, counts between 1 and 5 are reported as a range.

Figure 3: Hepatitis A hospitalisation rates,[a] Australia (selected states and territories),[b] 2016–2019,[c] by Aboriginal and Torres Strait Islander status



a Hospital admissions where hepatitis A is listed as the principal or other additional diagnosis.

b Jurisdictions with satisfactory data quality 2010–2019 (refer to Appendix A): Northern Territory, Queensland, New South Wales, Victoria, South Australia and Western Australia.

c Hospital admissions where the date of admission was between 1 January 2010 and 30 June 2019. 2019 hospitalisation data was annualised.

Discussion

Similar to the 2011–2015 period,[1] the hepatitis A notification rate for all ages combined in Aboriginal and Torres Strait Islander people was less than half that in other people over the 2016–2019 period, with no hepatitis A notifications or hospitalisations reported in Aboriginal and Torres Strait Islander children aged < 5 years.

A peak in hepatitis A notifications was observed in 2018, in both Aboriginal and Torres Strait Islander people and other people, likely contributed to by a multi-jurisdictional foodborne outbreak due to imported pomegranate arils.[54,55] In addition, hepatitis A outbreaks among men who have sex with men (MSM)—and to a lesser extent among people who inject drugs, homeless people and adult prisoners—were also reported in 2017 and 2018.[56,59] As a response to these outbreaks, state-funded hepatitis A vaccination programs targeting MSM and people who inject drugs ran from mid-2018 to November 2020 in Victoria, and until June 2020 in Tasmania.[60,61]

Prior to 2005, the rate of hepatitis A infection was higher among Aboriginal and Torres Strait Islander people, particularly in Western Australia, South Australia, Queensland and the Northern Territory.[3] In response, a national hepatitis A immunisation program targeted at Aboriginal and Torres Strait Islander children was introduced in 2005 in these four jurisdictions. This targeted immunisation program was successful in decreasing hepatitis A notifications

in Aboriginal and Torres Strait Islander people, despite relatively modest vaccine coverage, and also appeared to provide substantial herd protection to older children and adults, both Aboriginal and Torres Strait Islander and other.[62] Hepatitis A notification rates have remained consistently lower in Aboriginal and Torres Strait Islander people than in other Australians since 2007. Hepatitis A hospitalisation rates for both Aboriginal and Torres Strait Islander and other people remain generally low, consistent with low numbers of notified cases. However, the rate of hospitalisation among cases is high: during the multi-jurisdictional foodborne outbreak in Australia in 2018, 83% of hepatitis A cases were hospitalised.[54]

Targeted hepatitis A immunisation of high-risk groups in countries with low incidence is recommended by the World Health Organization[52] and has been largely effective in Australia to date. As well as Aboriginal and Torres Strait Islander children in the four states and territories listed above, Australia recommends hepatitis A vaccine for people with an increased risk of acquiring hepatitis A, including people travelling to countries with endemic hepatitis A, men who have sex with men, and people who inject drugs.[63] However, vaccination uptake among these populations is generally suboptimal.[64,65] Continued surveillance of hepatitis A remains important to inform future strategies for prevention of hepatitis A in Australia.

4. Hepatitis B

Relevant vaccine history

1980s
- Hepatitis B vaccination funded for high-risk infants, including Aboriginal and Torres Strait Islander infants, in some jurisdictions then nationally from 1988
- Hepatitis B vaccination recommended for at-risk adults, including all susceptible Aboriginal and Torres Strait Islander adults

1990
- Neonatal hepatitis B vaccination funded for all infants in the Northern Territory (three-dose schedule: birth, 1 month and 6 months)

1997–2013
- Hepatitis B vaccination recommended and funded for all adolescents aged 11–12 years (initially three-dose schedule using the paediatric formulation; changed to two-dose of adult formulation at various times since 2001 in different jurisdictions)

2000
- Universal infant vaccination funded under NIP with a birth dose of monovalent paediatric hepatitis B vaccine, followed by three doses of hepatitis B–containing combination vaccine

2013
- Funded adolescent school-based program ceased

1985–2018
- Aboriginal and Torres Strait Islander people progressively included in jurisdictionally-funded vaccination programs for at-risk individuals in Queensland (1985), New South Wales (2001), Northern Territory (2015; for people aged 20–50 years), South Australia (2016; for people aged > 15 years), Victoria (2017) and Tasmania (2018).

Hepatitis B infection is caused by the hepatitis B virus (HBV). Transmission of HBV occurs through contact with infected bodily fluids, such as from mother to child during labour; during sexual contact; or through the unsafe use of needles. The presentation of acute hepatitis B infection is varied, with the majority of infections in infants and children being asymptomatic, whereas adults frequently develop constitutional symptoms, jaundice and abdominal pain.[66] In 0.5–1% of adults, the acute infection can lead to fulminant liver failure, which has a high mortality rate without transplantation.[66] Progression from acute to chronic infection is inversely correlated with age: infected infants develop chronic hepatitis B in 95% of cases, whereas there is progression in fewer than 5% of adults.[66] Chronic hepatitis B can, over time, lead to liver fibrosis and cirrhosis, liver failure, and hepatocellular carcinoma.[66] In Australia, chronic hepatitis B is an important cause of hepatocellular carcinoma, which has an increasing incidence.[67] This chapter focuses on newly acquired hepatitis B notifications and on hospitalisations and deaths due to acute hepatitis B.

Results

Notification data for newly acquired hepatitis B infection, defined as infections confirmed to have been acquired in the prior two years, for all states and territories over the 2016–2019 period, are presented in Table 6. In total, there were 612 notifications in this period, of which 58 (9.5%) were reported to be in Aboriginal and Torres Strait Islander people. Newly acquired hepatitis B notification rates were significantly higher in Aboriginal and Torres Strait Islander people than in others, overall (RR: 3.7; 95% CI: 2.8–4.8) and in those aged 15–24 years (RR: 5.6; 95% CI: 2.6–11.1), 25–49 years (RR: 3.4; 95% CI: 2.3–4.9), and 50 years and over (RR: 3.8; 95% CI: 1.9–6.9).

Table 6: Newly acquired hepatitis B notifications,[a] Australia (all states and territories), 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Notifications[b] (2016–2019)			
		N	Rate[c]	Rate ratio	95%CI for Rate Ratio
0–4	Aboriginal and Torres Strait Islander	1	0.26	2.6	0.1–21.5
	Other	6	0.10		
5–14	Aboriginal and Torres Strait Islander	1	0.14	15.9	0.2–1246.7
	Other	1	0.01		
15–24	Aboriginal and Torres Strait Islander	11	1.73	5.6	2.6–11.1
	Other	38	0.31		
25–49	Aboriginal and Torres Strait Islander	34	3.36	3.4	2.3–4.9
	Other	331	0.98		
50+	Aboriginal and Torres Strait Islander	11	2.07	3.8	1.9–6.9
	Other	178	0.55		
All ages[d]	Aboriginal and Torres Strait Islander	58	2.12	3.7	2.8–4.8
	Other	554	0.57		

a Infection confirmed to have been acquired within the previous two years.

b Notifications where the date of diagnosis was between 1 January 2016 and 31 December 2019.

c Average annual age-specific rate per 100,000 population.

d Rates for all ages combined are age-standardised in standard population following the Australian Bureau of Statistics Australian population estimates for 2016.

Trends in newly acquired hepatitis B notification rates by Aboriginal and Torres Strait Islander status over the 2010–2019 period are presented in Figure 4. The notification rate in Aboriginal and Torres Strait Islander people for all age groups combined declined from 3.3 per 100,000 population in 2010 to 1.2 per 100,000 in 2018, but then increased to 2.7 per 100,000 in 2019. Notification rates in other people declined from 1.0 per 100,000 population in 2010 to 0.6 per 100,000 in 2019.

Hospital admissions for which acute hepatitis B was the principal diagnosis are shown for all jurisdictions for the 2016–2019 period in Table 7. In total, there were 320 hospital admissions for acute hepatitis B, of which 29 (9.1%) were in Aboriginal and Torres Strait Islander people. Notably, there were no hospitalisations for acute hepatitis B in children aged 0–4 years in this time period. Hospitalisation rates were significantly higher in Aboriginal and Torres Strait Islander people than in other people, overall (RR: 3.1; 95% CI: 2.0–4.4) and in those aged 5–14 years (RR: 95.1; 95% CI: 11.5–4373.5) and 25–49 years (RR: 3.1; 95% CI: 1.7–5.1).

Trends in acute hepatitis B hospitalisation rates are presented for six states and territories (excluding the Australian Capital Territory and Tasmania) over the 2010–2019 period in Figure 5. The hospitalisation rate in Aboriginal and Torres Strait Islander people peaked in 2012 at 1.9 per 100,000 population, declined to 0.4 per 100,000 in 2014, and then progressively increased to 1.5 per 100,000 in 2019. In other people, hospitalisation rates declined from 0.6 per 100,000 population in 2010 to 0.3 per 100,000 in 2019.

Over the 2016–2019 period, there were 56 deaths in Australia with acute hepatitis B identified as the underlying cause, 84% of which were in individuals aged 50 years or

Table 7: Hepatitis B hospitalisations,[a] Australia (all states and territories), 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Hospitalisations[b] (2016–2019)			
		n	Rate[c]	Rate ratio	95%CI for Rate Ratio
0–4	Aboriginal and Torres Strait Islander	0	0.00	0.0	0.0–0.0
	Other	0	0.00		
5–14	Aboriginal and Torres Strait Islander	6	0.94	95.1	11.5–4373.5
	Other	1-4[d]	0.01		
15–24	Aboriginal and Torres Strait Islander	1-4[d]	0.72	3.2	0.8–9.3
	Other	NP	0.22		
25–49	Aboriginal and Torres Strait Islander	16	1.81	3.1	1.7–5.1
	Other	173	0.59		
50+	Aboriginal and Torres Strait Islander	1-4[d]	0.65	2.0	0.4–6.0
	Other	93	0.33		
All ages[e]	Aboriginal and Torres Strait Islander	29	1.06	3.1	2.0–4.4
	Other	291	0.35		

a Principal cause of admission only, acute hepatitis B only.

b Hospital admissions where the date of admission was between 1 January 2016 and 30 June 2019. 2019 hospitalisation data was annualised.

c Average annual age-specific rate per 100,000 population.

d To comply with the AIHW's data release condition that hospitalisation counts < 5 be suppressed in published reports, counts between 1 and 4 are reported as a range; other cell counts may be reported at NP (not published) to avoid potential for back calculation of counts < 5.

e Rates for all ages combined are age-standardised to the ABS Australian population estimates for 2016.

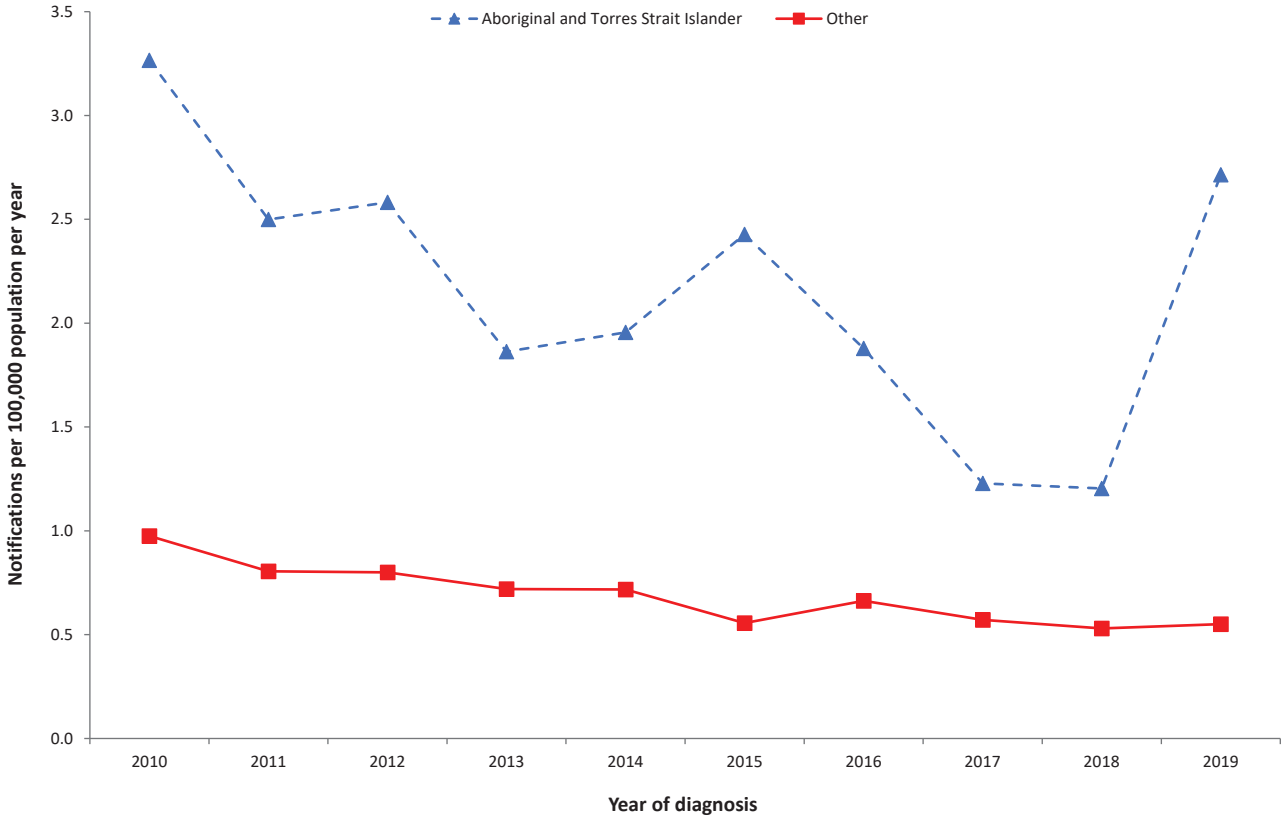
older. There were 1–5 deaths reported as being in Aboriginal and Torres Strait Islander people,[i] with none in people younger than 25 years of age.

Discussion

Notification rates of newly acquired hepatitis B infection for all ages combined, in both Aboriginal and Torres Strait Islander and other people, declined slightly but not significantly in the 2016–2019 period compared to the 2011–2015 period.[1] Notification rates in both groups in the 2016–2019 period were highest in the 25–49 years and lowest in the 0–4 and 5–14 years age groups. The very low incidence in both Aboriginal and Torres Strait Islander and other children under the age of 15 years (less than 0.3 per 100,000 population per year) demonstrates the success of inclusion of hepatitis B vaccination for all infants under the National Immunisation Program (NIP) since 2000. The success of this, and other immunisation programs, including adolescent immunisation under the NIP and jurisdictionally funded programs for at-risk groups, has led to reductions in chronic hepatitis B and sequelae.[68–71] Newly acquired hepatitis B notification rates in other age groups were not significantly different between the 2011–2015 and 2016–2019 periods. It is unclear why notification rates in Aboriginal and Torres Strait Islander people increased in 2019; this could be due in part to random variation related to

i To comply with the Australian Coordinating Registry's data release condition that death counts < 6 be suppressed in published reports, counts between 1 and 5 are reported as a range.

Figure 4: Newly acquired hepatitis B notification rates,[a] Australia (all states and territories), 2010–2019,[b] by Aboriginal and Torres Strait Islander status



a Infection confirmed to have been acquired within the previous two years.

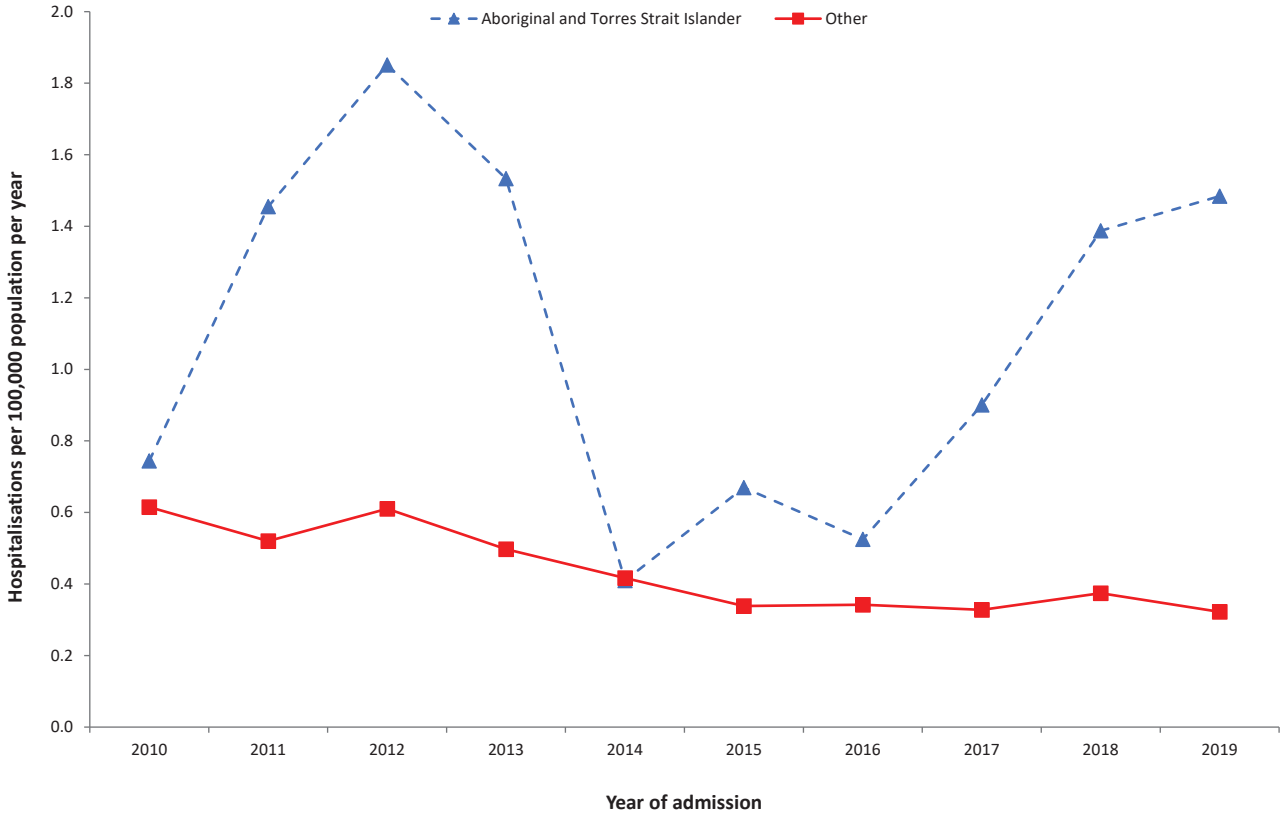
b Notifications where the date of diagnosis was between 1 January 2010 and 31 December 2019.

the relatively small number of cases involved. However, notification rates among Aboriginal and Torres Strait Islander adults have remained consistently higher than among other adults, suggesting ongoing horizontal transmission. Possible contributory factors include higher risk of exposure among high prevalence populations, lower vaccination coverage in previous school-based programs,[72,73] reduced vaccine efficacy due to mismatch between vaccine and circulating viral genotype,[74] and subtherapeutic antibody levels.[75]

There were no hospitalisations for acute hepatitis B among children aged younger than 5 years in the 2016–2019 period. In all other age groups, hospitalisation rates among Aboriginal and Torres Strait Islander people were higher than in other people, although only significantly so for the 5–14 (based on small numbers) and 25–49 years age groups, and for all ages combined. Hospitalisation rates in the 2016–2019 period were not significantly different compared to the 2011–2015 period.

While most states and territories now include susceptible Aboriginal and Torres Strait Islander adults in their funded vaccination programs, vaccination coverage through these programs is poorly documented and likely to be suboptimal. Strategies to improve uptake, either through existing jurisdictional programs, such as increasing awareness in Aboriginal and Torres Strait Islander Primary Health Care services and through general practices, or through inclusion on the NIP, would help reduce rates of both newly acquired and chronic hepatitis B,[76] and of hepatocellular carcinoma, which is approximately 2–6 times higher among Aboriginal and Torres Strait Islander people, and more commonly due to chronic hepatitis B, than in other people.[77–80]

Figure 5: Hepatitis B hospitalisation rates,[a,b] Australia (selected states and territories),[c] 2010–2019,[d] by Aboriginal and Torres Strait Islander status



a Principal cause of admission only, acute hepatitis B only.

b The previous report (2011–2015) included a figure demonstrating trends in hospitalisation rates of admissions where acute hepatitis B was the principal or an additional diagnosis.

c Jurisdictions with satisfactory data quality over the whole time period (refer to Appendix A); Northern Territory, Queensland, New South Wales, Victoria, South Australia and Western Australia.

d Hospital admissions where the date of admission was between 1 January 2010 and 30 June 2019; 2019 hospitalisation data annualised.

5. Human papillomavirus

Relevant vaccine history

2006
- The quadrivalent HPV vaccine (4vHPV), which protects against cancer-causing HPV types 16 and 18, and types 6 and 11 which cause genital warts, is released on the private Australian market

2007
- Bivalent HPV vaccine (2vHPV), which protects against cancer-causing HPV types 16 and 18, available on the private Australian market
- April 2007 – December 2008: School program for girls aged 12–18 years provides 4vHPV vaccine catchup program in a three-dose course under the NIP
- July 2007 – December 2009: Community-based program provides 4vHPV vaccine in a three-dose course under the NIP to all females aged 12–26 years in general practice and other community settings

2008
- National HPV Vaccination Program Register becomes operational

2009
- January 2009 – December 2012: Routine three-dose 4vHPV vaccine funded for females aged 12–13 years through school-based programs, with general practice and community providers giving some missed doses under the NIP

2013
- January 2013 – December 2014: Three-dose 4vHPV school-based vaccine program extended to males, with a catch-up program up to age 15 years under the NIP

2015
- Both sex routine 4vHPV vaccine school-based program delivered at age 12–13 years

2017
- Routine funded catch up HPV vaccination extended to age 19

2018
- Two-dose course of 9vHPV vaccination replaces three-dose 4vHPV course
- Bivalent HPV vaccine withdrawn from Australian market
- December 2018: National HPV Vaccination Program Register closes, with data migrated to Australian Immunisation Register

Human papillomavirus (HPV) causes a very common, usually transient, and asymptomatic infection of the genital tract in both women and men, with 13 types of HPV classified as oncogenic (cancer causing).[81] When infections with these oncogenic types persist, HPV can integrate into host epithelial cells and disrupt normal cellular repair mechanisms, and can eventually cause cancers of the genital tract (cervix, anus, penis, vulva and vagina) or mouth and throat. Other types of HPV are not associated with cancer; but types 6 and 11 cause genital warts and the rare disease recurrent respiratory papillomatosis, which can be acquired by newborns, from exposure at birth, or in young adults, likely due to sexual activity.

Cervical cancer in Australia disproportionately occurs in Aboriginal and Torres Strait Islander women who have twice the incidence and more than three times the mortality rate from the disease than do other Australian women.[82] This disparity is likely related to challenges faced by Aboriginal and Torres Strait Islander people in accessing culturally safe cervical screening and treatment services and may also be related to cofactors such as smoking and higher number of pregnancies.[83,84] Baseline HPV prevalence data, collected before commencement of the Australian HPV vaccination program, indicated that Aboriginal and Torres Strait Islander women had similar rates of HPV types 16 and 18, the most common cancer-causing types, as

other Australian women regardless of age, but in middle age had higher rates of other cancer-causing types detected.[83]

Results

HPV infection

HPV infection is common (estimated 90% lifetime probability of infection),[85] usually asymptomatic. HPV infection is not a nationally notifiable disease, although the detection of oncogenic HPV types, at levels predictive of the presence of precancerous cervical lesions, is routinely recorded through the National Cervical Screening Program. In 2019, rates of HPV detection among screening women aged 25–74 years were higher in the Northern Territory (11.3%) and in very remote areas (10.1%) than the overall national prevalence (8.5%).[86] However, no published data are available stratified by whether participants identified as Aboriginal and Torres Strait Islander people. Previous studies have documented dramatic reductions in prevalence of vaccine-targeted HPV types at the cervix by 95% in women aged 18–24 years: from 29% in 2005–2007 to 7% by 2011–2012,[87] and down to 1.5% by 2015.[88] A study to estimate the vaccine impact among Aboriginal and Torres Strait Islander women attending culturally appropriate services found a reduction of 93% (from 23.9% to 1.4%) in vaccine-preventable HPV types in women aged 18–26 years between the pre-vaccination (2007) and post-vaccination (2014–2015) periods.[89] HPV infection can also occur in the mouth, although persistent infection appears to be uncommon. A recent cross-sectional study found that HPV 16/18 was detected in the mouth of 3.3% of Aboriginal women and men in South Australia.[90] This is higher than Australian estimates in the general population of 1.3%.[91]

Genital warts

Decline in genital warts in young people in Australia was the first documented population-level impact of HPV vaccine internationally.[92] This occurred both in patients attending sexual health clinics and in those hospitalised. In patients attending sexual health clinics, a study reported significant declines in presentations with genital warts among Aboriginal and Torres Strait Islander women aged 12–20 years and 21–30 years and males aged 12–20 years between the two periods 2004–2007 and 2008–2014.[93] Updated data through to 2018 shows stable and low rates of genital warts diagnoses for Aboriginal and Torres Strait Islander people, with females aged younger than 21 years having shown an 84% reduction (from 6.4% in 2007 to 1.0% in 2018), whilst males aged younger than 21 years have shown an 81% reduction in genital warts diagnoses (from 7.2% to 1.4%).[94] Large declines were recorded in hospitalisations with genital warts between the periods 2006–2007 and 2010–2011 and a similar magnitude of decline in Aboriginal and Torres Strait Islander and other Australian women aged 15–24 years (76.1% [95% CI: 71.6–79.9%] and 86.7% [95% CI: 76.0–92.7%], respectively).[92] As shown in Figure 6 and Figure 7, downward trends in genital warts hospitalisations have continued for both Aboriginal and Torres Strait Islander people and other Australians younger than 30 years of age. Rates appear to also be decreasing in other Australian people aged 30–39 years, but not amongst Aboriginal and Torres Strait Islander people in this age group. Table 8a and Table 8b show, however, that average rates of genital warts hospitalisations in the period 2016–2019 were significantly higher amongst Aboriginal and Torres Strait Islander women aged older than 30 years than in other women, but the difference was not significant for Aboriginal and Torres Strait Islander men.

Cervical pre-cancer

Cervical screening aims to detect and then treat lesions of the cervix (known as high-grade cervical intraepithelial neoplasia [CIN]) before they develop into cervical cancer.

Historically, Australia's cervical screening registers have not routinely received information about the Aboriginal and Torres Strait Islander status of women participating in screening.

Table 8: Genital warts hospitalisations, Australia (all states and territories), 2016–2019, by gender ([a] female; and [b] male), age and Aboriginal and Torres Strait Islander status

a.Female

Age group (years)	Aboriginal and Torres Strait Islander status	Hospitalisations[a] (2016–2019)			
		N	Rate[b]	Rate ratio	95%CI for rate ratio
< 10	Aboriginal and Torres Strait Islander	1–5[c]	0.31	0.8	0.02–4.7
	Other	21	0.41		
10–19	Aboriginal and Torres Strait Islander	NP[c]	3.06	3.1	1.3–6.4
	Other	47	0.99		
20–29	Aboriginal and Torres Strait Islander	17	7.04	1.2	0.7–1.9
	Other	353	5.94		
30–39	Aboriginal and Torres Strait Islander	38	21.96	2.1	1.5–2.9
	Other	635	10.54		
≥ 40	Aboriginal and Torres Strait Islander	59	14.58	1.5	1.1–2.0
	Other	1,968	9.68		
All ages[d]	Aboriginal and Torres Strait Islander	124	8.65	1.2	0.998–1.4
	Other	3,024	7.18		

b.Male

Age group (years)	Aboriginal and Torres Strait Islander status	Hospitalisations[a] (2016–2019)			
		N	Rate[b]	Rate ratio	95%CI for rate ratio
< 10	Aboriginal and Torres Strait Islander	1–5[c]	0.59	4.5	0.5–23.8
	Other	7	0.13		
10–19	Aboriginal and Torres Strait Islander	1–5[c]	0.98	1.2	0.2–3.9
	Other	40	0.80		
20–29	Aboriginal and Torres Strait Islander	27	10.63	0.9	0.6–1.2
	Other	763	12.55		
30–39	Aboriginal and Torres Strait Islander	30	17.66	1.4	0.9–2.0
	Other	761	12.79		
≥ 40	Aboriginal and Torres Strait Islander	40	11.00	0.95	0.7–1.3
	Other	2,218	11.65		
All ages[d]	Aboriginal and Torres Strait Islander	102	7.12	0.8	0.6–0.95
	Other	3,789	9.14		

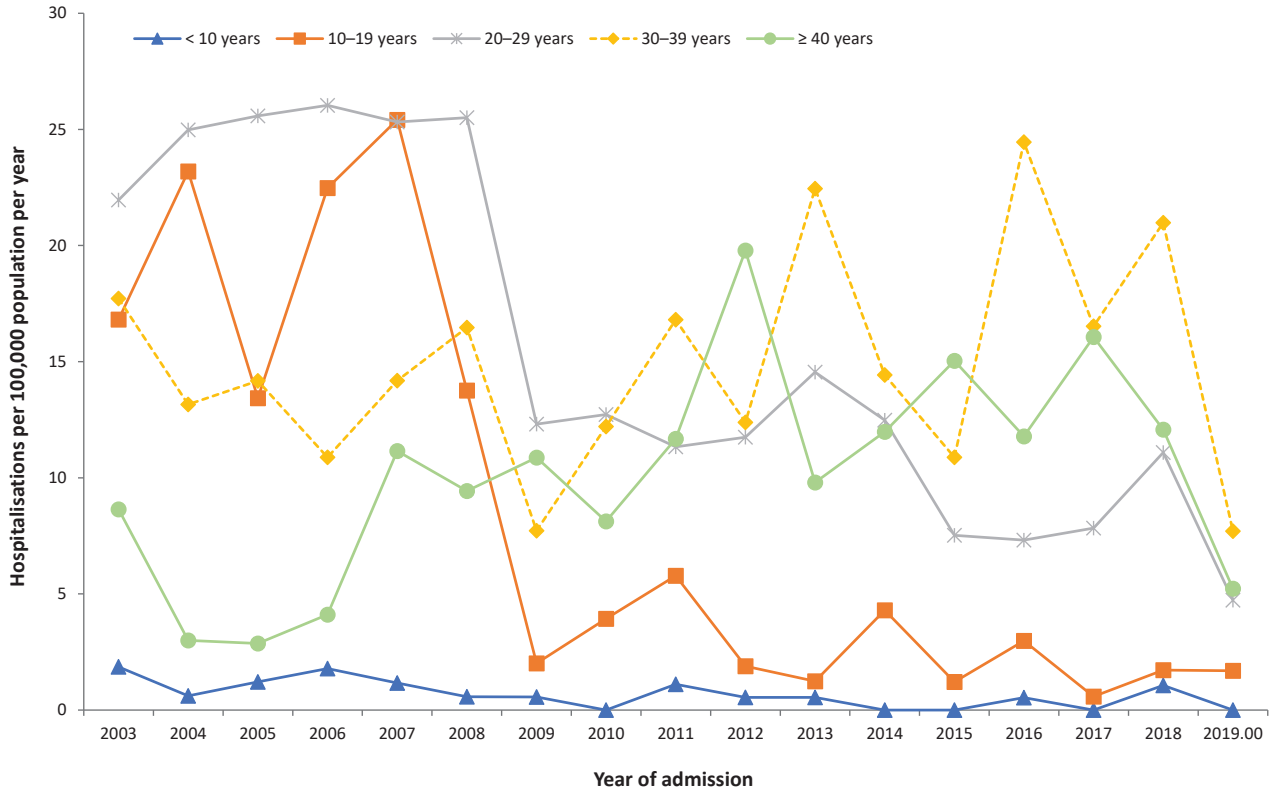
a Hospital admissions where the date of admission was between 1 January 2016 and 30 June 2019. 2019 hospitalisation data was annualised.

b Average annual age-specific rate per 100,000 population.

c To comply with the AIHW's data release condition that hospitalisation counts < 5 be suppressed in published reports, counts between 1 and 4 are reported as a range; other cell counts may be reported at NP (not published) to avoid potential for back calculation of counts < 5.

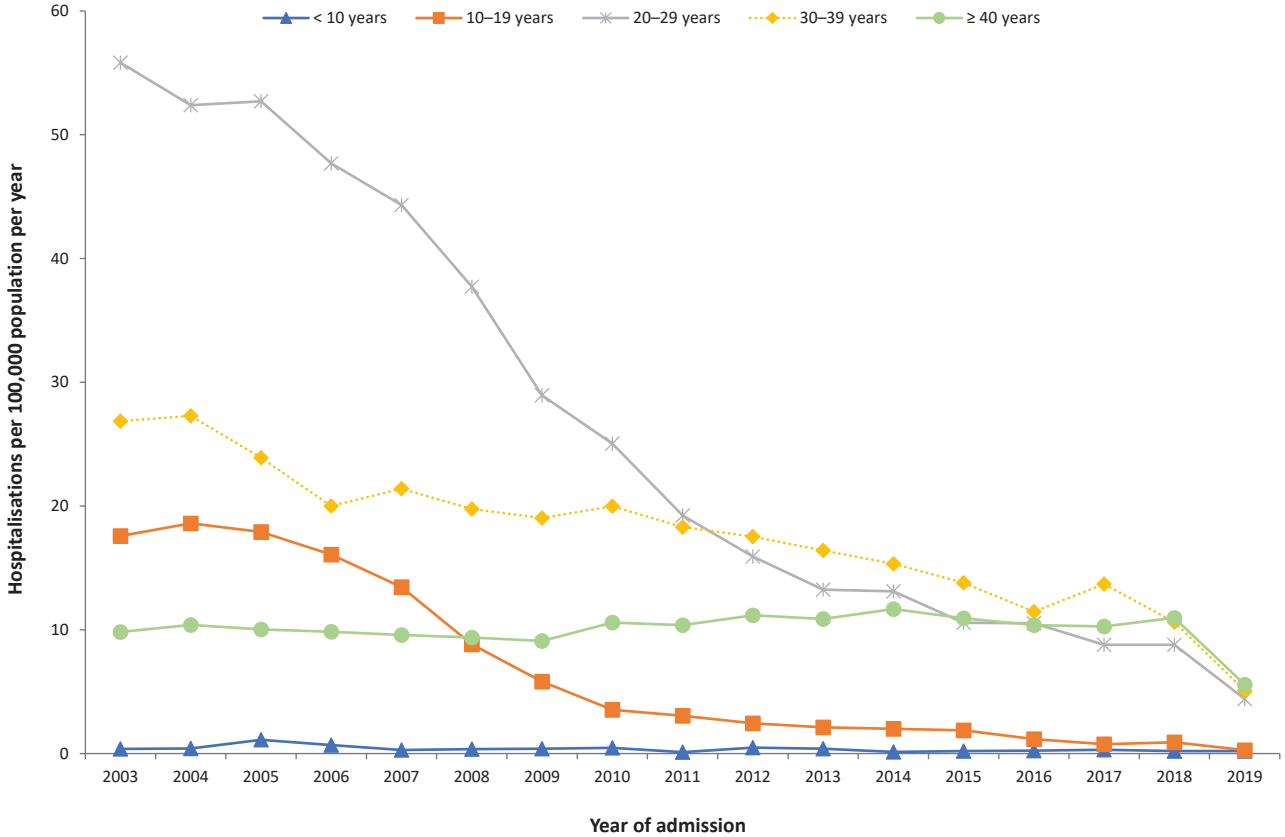
d Rates for all ages combined are age-standardised to the ABS Australian population estimates for 2016.

Figure 6: Genital warts hospitalisation rates, Aboriginal and Torres Strait Islander Australians, Australia (all states and territories), 2003–2019,[a] by age group



a Hospital admissions where the date of admission was between 1 January 2003 and 30 June 2019; 2019 hospitalisation data annualised.

Figure 7: Genital warts hospitalisation rates, other Australians, Australia (all states and territories), 2003–2019,[a] by age group



a Hospital admissions where the date of admission was between 1 January 2003 and 30 June 2019; 2019 hospitalisation data annualised.

However, the decline seen in cervical pre-cancer rates in the Northern Territory, where 31% of the female population is Aboriginal and Torres Strait Islander,[95] is similar to that observed nationally.[96] Between 2006 (the year before the vaccine program was introduced) and June 2017 (final year of the cytology-based screening program), the rate of detection of high-grade CIN decreased in the Northern Territory among women aged < 20 and 20–24 years by 100% and 53%, respectively, compared to decreases seen Australia-wide of 70% and 50% among these age groups. Vaccine coverage achieved in the Northern Territory has been comparable to the coverage in other jurisdictions.[97] As yet, no screening data are available from the HPV-based screening program by Aboriginal and Torres Strait Islander status from the National Cancer Screening Register (which replaced the eight jurisdictional cervical screening registers following transition to HPV-based screening in December 2017). This is due to as yet insufficiently complete data on Aboriginal and Torres Strait Islander status from either cervical screening tests or Medicare enrolment data (as completion of the Medicare Voluntary Indigenous Identifier is lower in older age groups than in childhood: 28% of people aged 25–74 who had a screening HPV test in 2018–2020 had not stated their Indigenous status.[82]

Cervical cancer incidence

HPV is responsible for almost all cervical cancers. The latest available Australian cervical cancer incidence data from 2016 demonstrates an incidence rate of 7.3 new cases per 100,000 women per year.[98] The incidence rate was 10.6 new cases per 100,000 per year for women aged 25–74 years, the age group eligible for cervical screening. From the most reliable, available data for 2011–2015 from New South Wales, Queensland, Western Australia and the Northern Territory, incidence for Aboriginal and Torres Strait Islander women was 19.3 new cases per 100,000 women per year. The incidence rate for Aboriginal and Torres Strait Islander women in the screening age group of 25–74 years was 19.9 new cases per 100,000 women per year.

There is currently no data link between Australian Immunisation Register vaccination status and cancer registry data. Linking these datasets would allow cervical cancer incidence to be reported by vaccination status.

Discussion

Since the introduction of the HPV vaccination program, Australia has observed remarkable reductions in HPV infection, genital warts, cervical precancers and, most recently, recurrent respiratory papillomatosis.[99] Available data suggest that Aboriginal and Torres Strait Islander people are benefitting as much as non-Indigenous Australians from the program, with substantial reductions in disease burden observed in vaccine-targeted age groups and leading to the reduction of previous inequity gaps.

The speed and size of reduction in HPV disease burden likely reflects the large-scale primary vaccination age cohort and catch-up program,[100] high vaccine efficacy with accumulating evidence that fewer than three doses provide a high degree of protection,[101] and greater than expected herd protection.[102] Modelling has suggested that even 30% coverage may generate herd protection and that sustained coverage above 80%, when vaccinating both males and females, is sufficient for long-term elimination of vaccine-targeted HPV types in the population.[102] All these factors may explain why reduction in disease burden and infection is as substantial among Aboriginal and Torres Strait Islander people as among non-Indigenous Australians despite somewhat lower rates of vaccine course completion.

It is important that Aboriginal and Torres Strait Islander status is asked about and recorded for all women participating in cervical screening. The new cervical screening program, which is now based on detection of HPV rather than

cervical cellular changes, combined with a new national screening register, should provide the vehicle for a national system of high-quality reporting, though to date no reporting by Aboriginal and Torres Strait Islander status has occurred.[103] Laboratory accreditation standards now require all pathology providers to transmit Aboriginal and Torres Strait Islander status to the register when reported to them, but do not currently mandate the inclusion of this field on pathology request forms.[104] It will also be important to ensure high-quality Aboriginal and Torres Strait Islander status reporting to cancer registers as the impact of vaccination on cervical cancer, and in future decades other HPV-related cancers, begins to materialise.

As we look to the future, Australia's leadership in cervical cancer prevention and control via the HPV vaccination program, coupled with our HPV-based cervical screening program, means that Australia is likely to be the first country to achieve cervical cancer elimination as a public health problem as defined by the World Health Organization (WHO) (< 4 cases per 100,000 women per year).[105,106] Key scale-up targets for countries outlined by the WHO to achieve by 2030 include:

- 90% of girls fully vaccinated with HPV vaccine by age 15 years;
- 70%+ of women screened with a high-performance test (such as HPV DNA testing) by age 35 years and again by 45 years; and
- 90%+ of women with screen-detected pre-cancer and 90%+ of women with cervical cancer receiving treatment.

HPV vaccine coverage in adolescents aged 15 years in 2019 was 78.2% (79.6% in females and 76.8% in males).[86] For Aboriginal and Torres Strait Islander adolescents, it was lower (68.5% overall; 71.6% in females and 65.4% in males). HPV vaccine coverage among other Indigenous populations appears to also be less than among their non-Indigenous counterparts.[107] Here in Australia[86]—and similarly in New Zealand, Canada and the United States of America—Indigenous populations are not on track to reach elimination and risk being left behind.[107]

6. Seasonal influenza

Relevant vaccine history

1986
- Seasonal influenza vaccination recommended for individuals at risk of complications or death from influenza

1994
- Seasonal influenza vaccination recommended for Aboriginal and Torres Strait Islander people aged ≥ 50 years

1999
- Seasonal influenza vaccine funded nationally for all Australians aged ≥ 65 years and Aboriginal and Torres Strait Islander people aged ≥ 50 years and 15–49 years with medical risk factors

2008
- Seasonal influenza vaccine recommended annually for all Aboriginal and Torres Strait Islander people aged ≥ 15 years

2009
- Pandemic influenza A (H1N1) 2009 vaccine registered, recommended and funded

2010
- Seasonal influenza vaccine funded for:
  – all Aboriginal and Torres Strait Islander people aged ≥ 15 years
  – all persons aged ≥ 6 months with medical conditions predisposing to severe influenza
  – pregnant women

2013
- Seasonal influenza vaccine recommended for children aged 6 months to < 5 years
- First inactivated quadrivalent influenza vaccine registered for use in individuals aged ≥ 3 years

2014
- Second inactivated quadrivalent influenza vaccine registered for use in individuals aged ≥ 6 months

2015
- Seasonal influenza vaccine funded for Aboriginal and Torres Strait Islander children aged 6 months to < 5 years
- List of population groups for which seasonal influenza vaccination recommended further expanded to include Aboriginal and Torres Strait Islander children aged 5–14 years

2016
- Quadrivalent influenza vaccines funded for use in those groups for which trivalent vaccine had been previously funded

2018
- Enhanced trivalent influenza vaccines (high-dose and adjuvanted) funded for all adults aged ≥ 65 years
- ACT, NSW, Qld, SA, Tas, Vic: annual seasonal influenza vaccination program funded for all children aged 6 months to < 5 years

2019
- Seasonal influenza vaccine funded for Aboriginal and Torres Strait Islander children and adolescents aged 5–14 years (now covering all Aboriginal and Torres Strait Islander people aged ≥ 6 months)

Influenza is an acute respiratory tract infection caused almost exclusively by influenza type A and type B viruses.[108] The most common serious complications from influenza include pneumonia (primary viral or bacterial co-infection) and exacerbation of underlying chronic lung or heart disease, such as chronic obstructive pulmonary disease, asthma and congestive heart failure.[109] The risk of developing serious complications is higher at both extremes of age (young children and older adults); in those with certain underlying medical conditions; and in pregnant women.[110–112] Vaccination is the main preventive strategy against influenza, but protection provided by vaccination varies from year to year, due to the propensity of

influenza A and B viruses to undergo frequent antigenic changes in two surface antigens, haemagglutinin and neuraminidase, producing variants against which vaccines may not be as effective.[113] Annual seasonal influenza vaccination is required, with vaccine formulation often changing from year to year.[114]

Results

A total of 714,488 influenza notifications were recorded for all ages combined between 2016 and 2019 across all states and territories, with Aboriginal and Torres Strait Islander status reported for 267,225 (37.4%). When restricting analyses to notifications with a reported Aboriginal and Torres Strait Islander status (i.e., omitting those with an unknown status), 16,163 influenza notifications (6.0%) were among Aboriginal and Torres Strait Islander people.

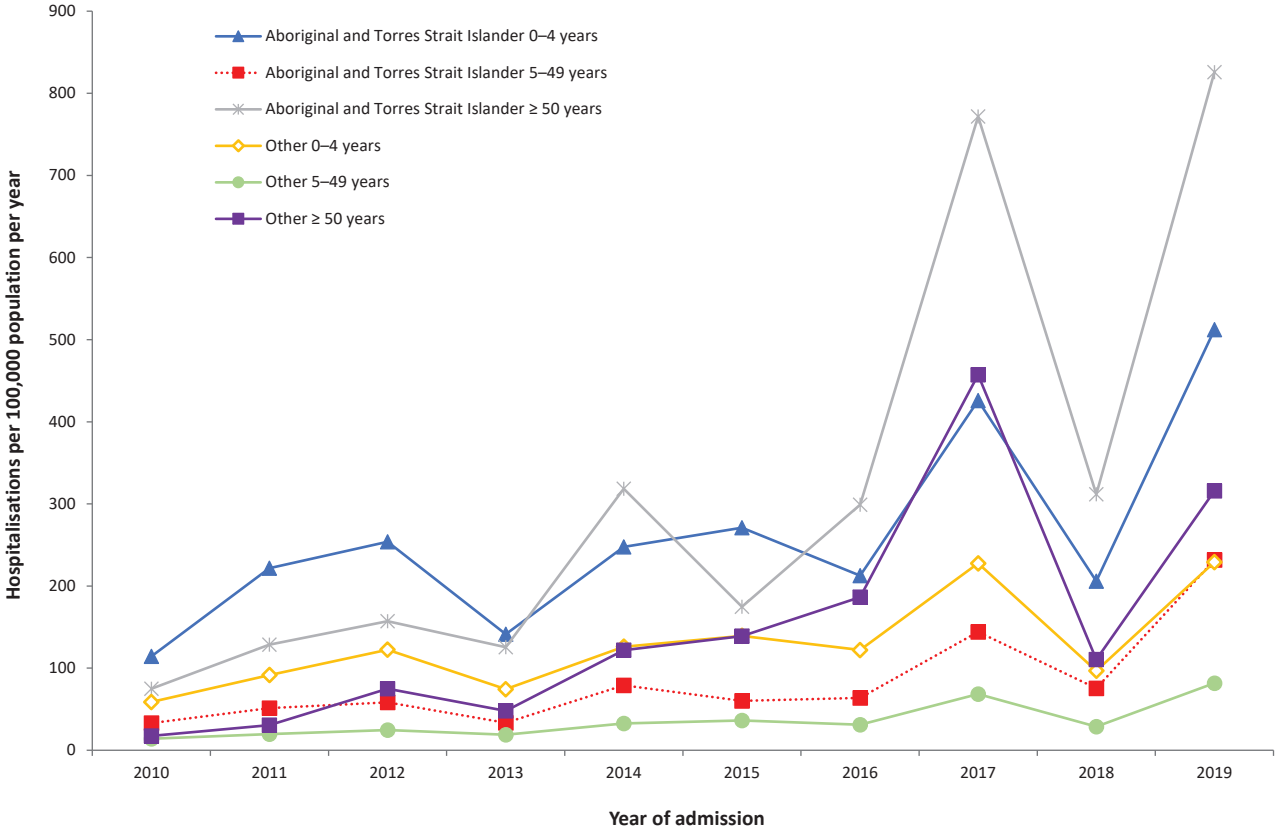
Notification data for laboratory confirmed cases of influenza are presented in Table 9 for the two jurisdictions—Western Australia and the Northern Territory—with adequate completeness of Aboriginal and Torres Strait Islander status (≥ 87%, compared to ≤ 68% for all other states and territories) for the 2016–2019 period. A total of 48,073 notifications were recorded in these two jurisdictions in the reporting period, of which 4,555 (9.5%) were in Aboriginal and Torres Strait Islander people, an overall Aboriginal and Torres Strait Islander versus other rate ratio of 1.5 (95% CI: 1.5–1.6). The highest age-specific notification rates were seen in the 6 months – < 1 year age group (1,307.8 per 100,000 population per year in Aboriginal and Torres Strait Islander infants, 536.9 per 100,000 per year in other infants; RR: 2.4; 95% CI: 1.9–3.1), followed by the < 6 months age group (1,134.3 per 100,000 per year in Aboriginal and Torres Strait Islander infants, 320.1 per 100,000 per year in other infants; RR: 3.5; 95% CI: 2.7–4.6) and the ≥ 50 years age group (1,128.9 per 100,000 per year in Aboriginal and Torres Strait Islander people, 424.5 per 100,000 per year in other people; RR: 2.7; 95% CI: 2.5–2.8). The notification rate was slightly lower in Aboriginal and Torres Strait Islander children and adolescents aged 5–14 years than other Australians in the same age group (RR: 0.8; 95% CI: 0.7–0.8), and similar in those aged 1–4 years (RR: 1.1; 95% CI: 0.95–1.2) and 15–24 years (RR: 1.1; 95% CI: 0.97–1.2).

Data on hospital admissions coded as due to influenza are presented for all jurisdictions for the 2016–2019 period in Table 10. The highest age-specific hospitalisation rates were in the < 6 months age group (744.7 per 100,000 per year in Aboriginal and Torres Strait Islander infants; 304.5 per 100,000 per year in other infants), 6 months to < 1 year (652.0 per 100,000 per year in Aboriginal and Torres Strait Islander infants; 235.6 per 100,000 per year in other infants), and ≥ 50 years age group (500.4 per 100,000 per year in Aboriginal and Torres Strait Islander people compared to 260.9 per 100,000 per year in other Australians). Hospitalisation rates were significantly higher for Aboriginal and Torres Strait Islander people across all age groups, with the all-age Aboriginal and Torres Strait Islander versus other hospitalisation RR = 2.1 (95% CI: 2.0–2.1) and highest age-specific rate ratio in the 25–49 years age group RR = 3.1 (95% CI: 3.0–3.3).

Trends in influenza hospitalisations by age and Aboriginal and Torres Strait Islander status are presented for six states and territories (excluding the Australian Capital Territory and Tasmania) for the 2010–2019 period in Figure 8. Peaks in hospitalisations were seen in 2017 and 2019. There was a generally increasing trend in hospitalisations rates from 2010 to 2019 across all age groups, with the greatest increase in the ≥ 50 years age group, from 299.0 per 100,000 per year in 2016 to 825.8 per 100,000 per year in 2019 in Aboriginal and Torres Strait Islander people and from 186.4 to 315.9 per 100,000 per year in other people.

Between 2016 and 2019, there were 3,689 deaths with influenza as underlying or associated cause reported in Australia, with 68 of these (1.8%) recorded in Aboriginal or Torres Strait Islander people. The ≥ 50 years age group accounted for

Figure 8: Influenza hospitalisation rates, Australia (selected states and territories),[a] 2010–2019,[b] by age and Aboriginal and Torres Strait Islander status



a States and territories with satisfactory data quality for the 2010–2019 period (refer to Appendix A): the Northern Territory, Queensland, New South Wales, Victoria, South Australia and Western Australia.

b Hospital admissions where the date of admission was between 1 January 2010 and 30 June 2019. Hospitalisation data for 2019 was annualised.

77.9% of deaths (53/68) in Aboriginal and Torres Strait Islander people and 96.4% (3,491/3,621) among other Australians.

Discussion

All-age influenza notification and hospitalisation rates were higher in the 2016–2019 than the 2011–2015 period:[1] 67% and 220% higher, respectively, in Aboriginal and Torres Strait Islander people and 38% and 250% in other people, reflecting the severe influenza A/H3N2 seasons in both 2017 and 2019.[115] Hospitalisation rates in the 2016–2019 period were highest in infants and in adults aged ≥ 50 years, with rates in Aboriginal and Torres Strait Islander people significantly higher (1.5 to 3-fold) across all age groups, as found in other studies over this and previous periods.[1,110,116] Longer term increasing trends in both notifications and hospitalisations are likely contributed to by increased availability and use of PCR testing.[110,117]

In the 2016–2019 period, as in the 2011–2015 period, influenza was responsible for the largest number of notifications and hospitalisations of any VPD. Influenza has been estimated to contribute more than one third (36%) of the total burden of VPDs in Australia in terms of disability adjusted life years.[16]

Influenza vaccination coverage was higher in 2019 in Aboriginal and Torres Strait Islander people than in other people across all age groups (see vaccination coverage chapter). However, given the substantial burden of disease, vaccination uptake remains suboptimal, particularly among Aboriginal and Torres Strait Islander

Table 9: Influenza notifications, Australia (selected states and territories),[a] 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group[b] (years)	Aboriginal and Torres Strait Islander status	Notifications[c] (2016–2019)			
		n	Rate[d]	Rate ratio	95% CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	566	757.7	1.3	1.2–1.4
	Other	3,968	572.9		
0 –< 6 months	Aboriginal and Torres Strait Islander	85	1,134.3	3.5	2.7–4.6
	Other	220	320.1		
6 months –< 1 year	Aboriginal and Torres Strait Islander	98	1,307.8	2.4	1.9–3.1
	Other	369	536.9		
1–4 years	Aboriginal and Torres Strait Islander	383	641.3	1.1	0.95–1.17
	Other	3,379	608.6		
5–14	Aboriginal and Torres Strait Islander	734	493.7	0.8	0.7–0.8
	Other	8,465	643.6		
15–24	Aboriginal and Torres Strait Islander	498	374.0	1.1	0.97–1.2
	Other	4,524	349.9		
25–49	Aboriginal and Torres Strait Islander	1,472	591.6	1.9	1.8–2.0
	Other	12,025	309.3		
≥ 50	Aboriginal and Torres Strait Islander	1,285	1,128.9	2.7	2.5–2.8
	Other	14,536	424.5		
All ages[e]	Aboriginal and Torres Strait Islander	4,555	633.4	1.5	1.5–1.6
	Other	43,518	410.1		

a Western Australia and the Northern Territory.

b Age in months for the 0 –< 6 month and 6 months –< 1 year age groups was calculated by subtracting the mid-point of date of birth (MM/YYYY) from diagnosis date to determine age in weeks. All other age groups were determined using the age at onset (age in years) field from NNDSS.

c Notifications where the date of diagnosis was between 1 January 2016 and 31 December 2019.

d Average annual age-specific rate per 100,000 population.

e Rates for all ages combined are age-standardised to the Australian Bureau of Statistics Australian population estimates for 2016.

people aged < 65 years of age. It is important that influenza vaccination for Aboriginal and Torres Strait Islander people of all ages be strongly promoted, and ways to reduce any barriers to uptake explored and implemented, to address the high levels of morbidity and mortality associated with this disease.

Table 10: Influenza hospitalisations, Australia (all states and territories), 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group[a] (years)	Aboriginal and Torres Strait Islander status	Hospitalisations[b] (2016–2019)			
		n	Rate[c]	Rate ratio	95% CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	1,012	306.9	1.9	1.8–2.0
	Other	8,323	160.7		
0 –< 6 months	Aboriginal and Torres Strait Islander	249	744.7	2.5	2.1–2.8
	Other	1,543	304.5		
6 months –< 1 year	Aboriginal and Torres Strait Islander	218	652.0	2.8	2.4–3.2
	Other	1,194	235.6		
1–4 years	Aboriginal and Torres Strait Islander	545	207.3	1.6	1.4–1.7
	Other	5,585	134.1		
5–14	Aboriginal and Torres Strait Islander	421	65.9	1.4	1.3–1.6
	Other	4,722	46.6		
15–24	Aboriginal and Torres Strait Islander	455	82.0	2.0	1.8–2.2
	Other	4,379	41.0		
25–49	Aboriginal and Torres Strait Islander	1,442	163.5	3.1	3.0–3.3
	Other	15,384	52.5		
≥ 50	Aboriginal and Torres Strait Islander	2,305	500.4	1.9	1.8–2.0
	Other	73,809	260.9		
All ages[d]	Aboriginal and Torres Strait Islander	5,635	261.5	2.1	2.0–2.1
	Other	106,617	126.2		

a Age was determined using the age in months field for the 0 –< 6 month and 6 months –< 1 year age groups. All other age groups were determined using the age at onset (age in years) field.

b Hospital admissions where the date of admission was between 1 January 2016 and 30 June 2019. 2019 data annualised.

c Average annual age-specific rate per 100,000 population.

d Rates for all ages combined are age-standardised to the Australian Bureau of Statistics Australian population estimates for 2016.

7. Measles

Relevant vaccine history

1975
- Measles vaccine funded for all Australian infants at 12 months of age

1984
- MM[i] vaccination of Aboriginal and Torres Strait Islander children in the Northern Territory scheduled at 9 months of age instead of 12 months

1989
- MMR[ii] vaccine recommended and funded on the national schedule at 12 months of age (9 months for Aboriginal and Torres Strait Islander infants in the Northern Territory)

1992
- Second dose of MMR vaccine recommended and funded for all adolescents 10–14 years

1998
- Recommended age for first dose of MMR vaccine for Aboriginal and Torres Strait Islander infants in the Northern Territory increased from 9 months to 12 months of age
- Recommended age of second dose of MMR vaccine scheduled at 4–5 years instead of 10–14 years

2000
- Second dose of MMR vaccine scheduled at 4 years instead of 4–5 years

2013
- Second dose of MMR vaccine moved forward to 18 months of age, administered as MMRV[iii]

2019
- Recommended age at which infants can receive MMR vaccine for travel to highly endemic areas, during outbreaks, and as post-exposure prophylaxis, lowered to 6 months

Measles is a highly contagious airborne disease caused by the measles morbillivirus. It is characterised by fever, malaise, conjunctivitis, coryza and cough during the prodromal stage, followed by the onset of a maculopapular rash.[118] The severity of measles illness, complication rates and clinical outcomes vary with age, but there is increased risk in children aged < 5 years and adults aged ≥ 20 years.[118] Complications include otitis media, pneumonia, diarrhoea, postinfectious encephalitis, subacute sclerosing panencephalitis (rare) and death.[118]

Results

Notification data for measles are presented for all states and territories for the 2016–2019 period in Table 11. A total of 568 notifications were recorded, of which 12 (2.1%) were reported in Aboriginal and Torres Strait Islander people. The highest notification rate in both Aboriginal and Torres Strait Islander and other people was in children aged less than 5 years (0.8 and 1.4 per 100,000 population per year, respectively). Of the 85 measles notifications recorded in children aged less than 5 years old, 55 (64.7%) were among children less than one year old. There were no statistically significant differences between notification rates in Aboriginal and Torres Strait Islander people and other people by age group; however, the notification rate was significantly lower among Aboriginal and Torres Strait Islander people overall (RR: 0.49; 95% CI: 0.2–0.9). Of the 568 notifications of measles over the 2016–2019 period, Aboriginal and Torres Strait Islander status was reported for 97.5%.

Notification trends for measles are presented for all states and territories for the 2010–2019 period in Figure 9. Notification rates in both Aboriginal and Torres Strait Islander people and other Australians were below 1.8 per 100,000

i MM: measles and mumps.

ii MMR: measles, mumps and rubella.

iii MMRV: measles, mumps, rubella and varicella.

Table 11: Measles notifications, Australia (all states and territories), 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Notifications[a] (2016–2019)			
		N	Rate[b]	Rate ratio	95% CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	3	0.79	0.6	0.1–1.7
	Other	82	1.39		
5–14	Aboriginal and Torres Strait Islander	2	0.27	0.7	0.1–2.6
	Other	46	0.40		
15–24	Aboriginal and Torres Strait Islander	3	0.47	0.4	0.1–1.1
	Other	154	1.26		
25–49	Aboriginal and Torres Strait Islander	4	0.39	0.5	0.1–1.3
	Other	260	0.77		
50+	Aboriginal and Torres Strait Islander	0	0.00	0.0	0.0–18.4
	Other	14	0.04		
All ages[c]	Aboriginal and Torres Strait Islander	12	0.29	0.49	0.2–0.9
	Other	556	0.59		

a Notifications where the date of diagnosis was between 1 January 2016 and 31 December 2019.

b Average annual age-specific rate per 100,000 population.

c Rates for all ages combined are age-standardised in standard population following the Australian Bureau of Statistics Australian population estimates for 2016.

population per year over the ten-year period. The notification rate fluctuated more from year to year among Aboriginal and Torres Strait Islander people, likely due to lower numbers of cases, with peaks in 2012, 2014, 2017 and 2019 decreasing in magnitude, and peaks in 2014 and 2019 in other Australians.

Hospitalisation data are presented for all jurisdictions for the 2016–2019 period in Table 12. Of the 223 hospitalisations recorded, five (2.2%) were reported in Aboriginal and Torres Strait Islander people. As with notifications, the highest hospitalisation rate in both Aboriginal and Torres Strait Islander and other people was in children aged less than 5 years (0.6 and 0.9 per 100,000 population per year, respectively). There were no statistically significant differences between hospitalisation rates in Aboriginal and Torres Strait Islander and other people in any age group or for all ages combined. Hospitalisation trends are not presented, due to the small number of hospitalisations in Aboriginal and Torres Strait Islander people.

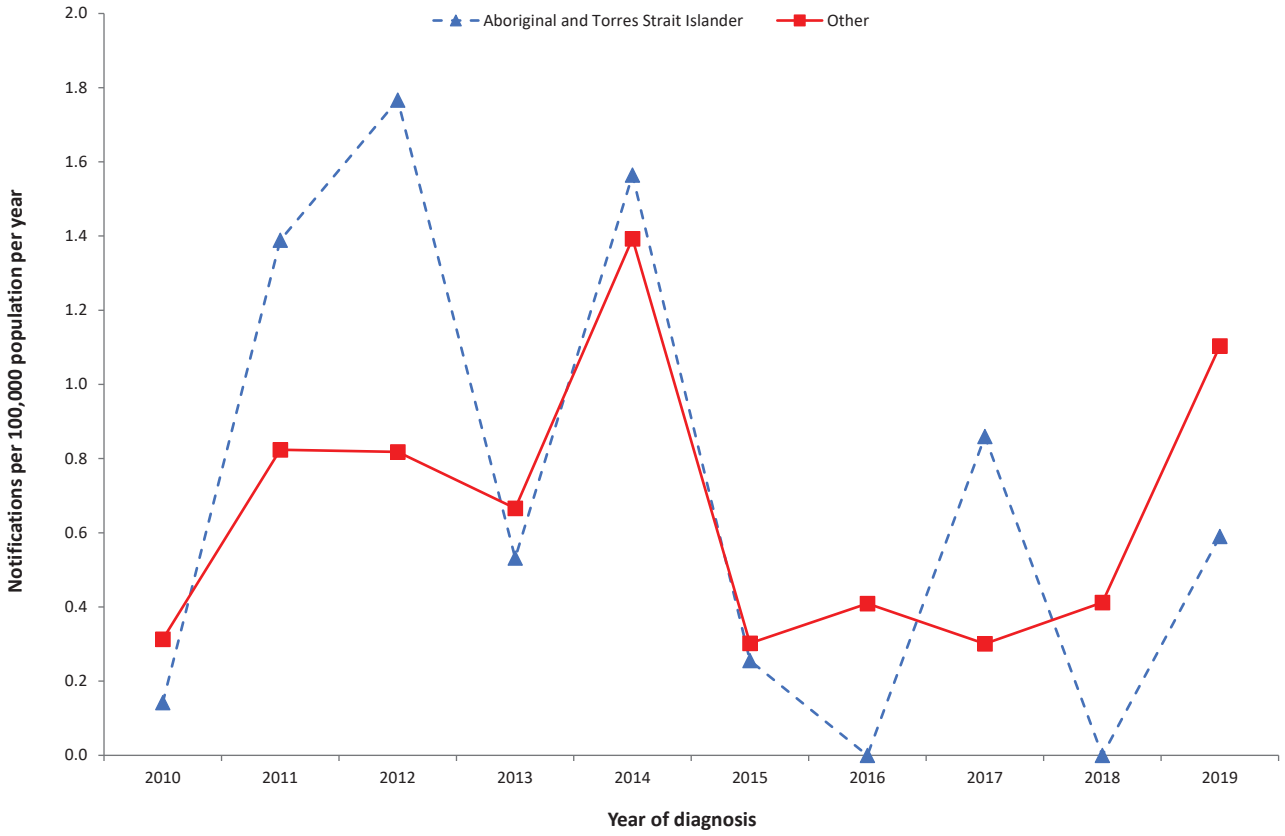
There were 1–5 deaths reported in Australia for the period 2016–2019 where measles was recorded as an associated cause of death,[iv] with none reported in Aboriginal and Torres Strait Islander people. There were no deaths where measles was recorded as the underlying cause of death.

Discussion

Measles notification and hospitalisation rates in Aboriginal and Torres Strait Islander people remained low and were below 1 per 100,000 population per year for all age groups in the 2016–2019 period. The all age notification rate in Aboriginal and Torres Strait Islander people was 68% lower in the 2016–2019 period than in the 2011–2015 period (0.29 and 0.91 per 100,000 per year, respectively) and was half the notification rate in other Australians in 2016–2019. Although only three measles cases were notified among Aboriginal and Torres

iv To comply with the Australian Coordinating Registry's data release condition that death counts < 6 be suppressed in published reports, counts between 1 and 5 are reported as a range.

Figure 9: Measles notification rates, Australia (all states and territories), 2010–2019,[a] by Aboriginal and Torres Strait Islander status



a Notifications where the date of diagnosis was between 1 January 2010 and 31 December 2019.

Strait Islander children aged less than five years old, this age group had the highest age-specific notification rate in both Aboriginal and Torres Strait Islander and other people, with almost two-thirds of cases in this age group in infants aged less than one year. This is consistent with previous analyses of Australian notification data between 2012 and 2019 which found the highest rate of measles notifications among infants aged less than one year and therefore not yet eligible to receive MMR vaccine, likely due to increased susceptibility from declining placenta-transmitted maternal antibodies in an elimination context.[119,120]

Measles vaccination coverage is high among Aboriginal and Torres Strait Islander children (see vaccination coverage chapter). Furthermore, following the introduction of the 'No Jab, No Pay' policy on 1 January 2016, catch-up second-dose MMR vaccination rates among adolescents aged 10–20 years increased and were higher among Aboriginal and Torres Strait Islander than other adolescents.[121] In the context of low measles incidence, high vaccination coverage among children, the effects of No Jab, No Pay and the elimination of endemic measles in Australia verified in 2014, outbreaks linked to imported cases in travellers sporadically occur. The Northern Territory experienced an outbreak in 2019 on a background of a surge in measles cases worldwide[122–124] and the recommended age of first dose of MMR was lowered to 9 months in the Greater Darwin region for the duration of the outbreak.[124] In the same year, the recommended age at which infants can receive the MMR vaccine for travel to endemic areas, during outbreaks and as post-exposure prophylaxis was lowered to 6 months.[125] To prevent importation of measles into Australia, identification and vaccination of non-immune individuals travelling to countries with endemic measles should remain a focus.

Table 12: Measles hospitalisations, Australia (all states and territories), 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Hospitalisations[a] (2016–2019)			
		N	Rate[b]	Rate ratio	95%CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	1–4[c]	0.61	0.7	0.1–2.5
	Other	48	0.93		
5–14	Aboriginal and Torres Strait Islander	0	0.00	0.0	0.0–8.0
	Other	9	0.09		
15–24	Aboriginal and Torres Strait Islander	0	0.00	0.0	0.0–1.6
	Other	47	0.44		
25–49	Aboriginal and Torres Strait Islander	1–4[c]	0.34	1.0	0.2–3.1
	Other	97	0.33		
50+	Aboriginal and Torres Strait Islander	0	0.00	0.0	0.0–14.9
	Other	17	0.06		
All ages[d]	Aboriginal and Torres Strait Islander	5	0.16	0.6	0.2–1.6
	Other	218	0.26		

a Hospital admissions where the date of admission was between 1 January 2016 and 30 June 2019. Hospitalisation data for 2019 was annualised.

b Average annual age-specific rate per 100,000 population.

c To comply with the AIHW's data release condition that hospitalisation counts < 5 be suppressed in published reports, counts between 1 and 4 are reported as a range; other cell counts may be reported as NP (not published) to avoid potential for back calculation of counts < 5.

d Rates for all ages combined are age-standardised to the ABS Australian population estimates for 2016.

8. Meningococcal disease

Relevant vaccine history

2003
- Meningococcal C conjugate vaccine funded for children at 12 months of age in the NIP, with a catch-up program for individuals aged 1–19 years of age (catch-up concluded in 2008)

2014
- Multicomponent recombinant meningococcal B vaccine available in Australia, and recommended (not funded) for at-risk individuals

2016-2019
- Various meningococcal ACWY conjugate vaccine programs commenced for children, adolescents up to age 19 years, at-risk individuals, or a combination of these funded in all Australian jurisdictions

2018
- Meningococcal ACWY conjugate vaccine funded for children aged 12 months under the NIP in July (replacing meningococcal C vaccination at 12 months of age)
- South Australia commences state-funded Meningococcal B Immunisation Program for children aged 6 weeks to 12 months, with a catch-up program for children aged 12 months to less than 4 years (catch-up concluded 31 December 2019)

2019
- Meningococcal ACWY conjugate vaccine funded under the NIP for adolescents aged 14–16 years delivered through a school-based program, and 15–19 years through primary care providers
- South Australia commences state-funded meningococcal B vaccination program for adolescents in year 10, with catch-up for year 11 students and those aged 17 to < 21 years (catch-up concluded February 2020)

Meningococcal disease is caused the bacterium *Neisseria meningitidis*, which has 13 serogroups. The most common serogroups causing human disease worldwide are A, B, C, W and Y.[126,127] Invasive meningococcal disease (IMD), defined as the isolation of this bacterium in normally sterile sites, most often presents as acute meningitis with fever, headache, and photophobia, or as septicaemia with or without meningitis.[127] With appropriate treatment, case fatality rates for IMD range from 4% to 20%.[128] Between 10% and 30% of survivors of IMD develop permanent sequelae, including hearing loss, cognitive deficits, seizure disorders, and extensive skin complications that may lead to limb amputations.[129–131]

Results

Notification data for IMD of all serogroups for the period 2016–2019 are presented in Table 13. In total, there were 1,120 IMD notifications, of which 170 (15.2%) were reported to be in Aboriginal and Torres Strait Islander people.

The overall (all ages combined) notification rate among Aboriginal and Torres Strait Islander people at 3.5 per 100,000 per year was substantially higher than the rate among other people at 1.0 per 100,000 per year (RR: 3.5; 95% CI: 2.9–4.3). The highest age-specific notification rates were seen in Aboriginal and Torres Strait Islander children aged 0–4 years (27.0 per 100,000 per year compared to 2.8 per 100,000 per year in other children; RR: 9.7; 95% CI: 7.5–12.6) and Aboriginal and Torres Strait Islander children/adolescents aged 5–14 years (4.7 per 100,000 per year compared to 0.2 per 100,000 per year in other children/adolescents; RR: 20.0; 95% CI: 11.7–34.5). The next highest notification rate in Aboriginal and Torres Strait Islander people was in adults aged 25–49 years

Table 13: Invasive meningococcal disease notifications, Australia (all states and territories), 2016–2019, by age and Aboriginal and Torres Strait Islander status

		Notifications (2016–2019)[a]			
Age group (years)	Aboriginal and Torres Strait Islander status	N	Rate[b]	Rate ratio	95% CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	102	27.02	9.7	7.5–12.6
	Other	164	2.77		
5–14	Aboriginal and Torres Strait Islander	34	4.65	20.0	11.7–34.5
	Other	27	0.23		
15–24	Aboriginal and Torres Strait Islander	10	1.57	0.8	0.4–1.4
	Other	251	2.05		
25–49	Aboriginal and Torres Strait Islander	18	1.78	3.9	2.2–6.3
	Other	154	0.46		
50+	Aboriginal and Torres Strait Islander	6	1.13	1.0	0.4–2.3
	Other	354	1.09		
All ages[c]	Aboriginal and Torres Strait Islander	170	3.53	3.5	2.9–4.3
	Other	950	1.00		

a Notifications where the date of diagnosis was between 1 January 2016 and 31 December 2019.

b Average annual age-specific rate per 100,000 population.

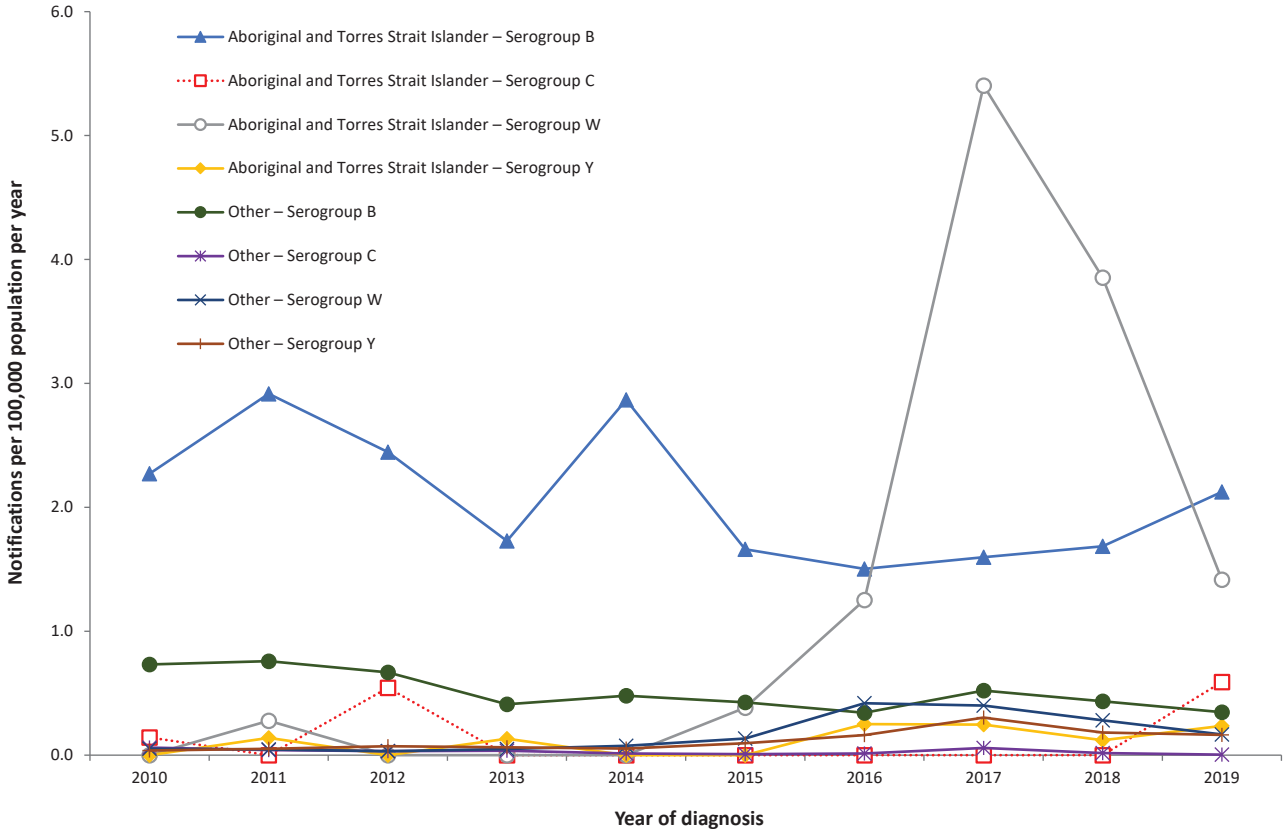
c Rates for all ages combined are age-standardised in standard population following the Australian Bureau of Statistics Australian population estimates for 2016.

(1.8 per 100,000 per year compared to 0.5 per 100,000 per year in other adults; RR: 3.9; 95% CI: 2.2–6.3).

Trends in IMD notifications for the 2010–2019 period, by Aboriginal and Torres Strait Islander status and serogroup, are presented in Figure 10. Data completeness of serogroup improved from 90.7% in 2010 to 98.6% in 2019. The notification rate of serogroup B IMD in Aboriginal and Torres Strait Islander people fluctuated between 1.5 and 2.9 per 100,000 per year over this 2010–2019 period, with an increasing trend in the current reporting period (2016–2019). In other people, serogroup B notifications peaked at 0.8 per 100,000 in 2011, and remained under 0.5 per 100,000 per year from 2013 onwards. Notification rates of serogroup B IMD in the period 2016–2019 were highest in South Australia for both Aboriginal and Torres Strait Islander and other people at 4.6 and 1.2 per 100,000 per year, respectively. In the remaining states and territories, rates ranged between 0 and 2.0 per 100,000 among Aboriginal and Torres Strait Islander people, and between 0.1 and 0.7 per 100,000 per year among other people. Between 2016 and 2019, serogroup B notification rates were higher in Aboriginal and Torres Strait Islander children/adolescents aged 0–14 years than in other children/adolescents. There were 42 notifications of serogroup B IMD in Aboriginal and Torres Strait Islander children aged 0–4 years (11.1 per 100,000 per year) and 100 in other children (1.7 per 100,000 per year; RR: 6.6; 95% CI: 4.5–9.5), with 11 notifications in Aboriginal and Torres Strait Islander children/adolescents aged 5–14 years (1.5 per 100,000 per year) and 18 in other children/adolescents (0.2 per 100,000 per year; RR: 9.7; 95% CI: 4.1–21.7).

Notifications of serogroup W IMD emerged from 2015 onwards, peaking at 44 (5.4 per 100,000 per year) in 2017 in Aboriginal and Torres Strait Islander people, and 98 (0.4 per 100,000 per year) in 2016 in other people.

Figure 10: Meningococcal disease notification rates, Australia (all states and territories), 2010–2019,[a] by Aboriginal and Torres Strait Islander status and serogroup



a Notifications where the date of diagnosis was between 1 January 2010 and 31 December 2019.

In the 2016–2019 period, the overall serogroup W IMD notification rate in Aboriginal and Torres Strait Islander people was 3.0 per 100,000 per year compared to 0.3 per 100,000 per year in other people (RR: 9.5; 95% CI: 7.44–11.91). Notification rates of serogroup W IMD among Aboriginal and Torres Strait Islander people were particularly high in the Northern Territory, Western Australia and South Australia at 10.9, 9.0 and 5.2 per 100,000 per year, respectively, compared to between 0.4 and 3.2 per 100,000 per year in the other states and territories. Serogroup W IMD notification rates were highest among Aboriginal and Torres Strait Islander children aged 0–4 years (58 notifications, rate 15.4 per 100,000 per year; compared to 33 notifications, rate 0.6 per 100,000 per year among other children; RR: 27.5; 95% CI: 17.7–43.6); and among children/adolescents aged 5–14 years (21 notifications, rate 2.9 per 100,000 per year; compared to 3 notifications, rate 0.03 per 100,000 per year in other children/adolescents; RR: 111.2; 95% CI: 33.2–582.1).

Notifications of serogroup Y IMD also emerged in 2015, peaking at 72 (0.3 per 100,000 per year) in 2017. Serogroup Y IMD predominantly affected older age groups (mean age = 48 years), with notification rates in the 2016–2019 period similar in Aboriginal and Torres Strait Islander and other people.

The notification rate of serogroup C IMD was low in both Aboriginal and Torres Strait Islander and other Australians throughout the 2010–2019 period. Apart from two notifications of serogroup E in 2018, there were no notifications of any other serogroups between 2010 and 2019.

In the period 2016–2019, the meningococcal disease hospitalisation rate was higher in Aboriginal and Torres Strait Islander people than in other people (RR: 3.2; 95% CI: 2.7–3.8), particularly in the age groups 0–4 years (RR: 7.5; 95% CI: 6.0–9.4) and 5–14 years (RR: 13.2; 95% CI: 8.9–19.5). More detailed hospitalisation data are not reported here due to known limitations in interpretation of hospitalisation data relating to meningococcal disease. While virtually all cases of IMD require hospitalisation, duplicate data due to inter-hospital transfers or readmissions cannot be excluded and serogroup-specific data are lacking.

There were 67 deaths in the 2016–2019 period with meningococcal disease as the underlying (n = 62) or associated (n = 5) cause of death, of which 11 (16%) were recorded as being in Aboriginal and Torres Strait Islander people.

Discussion

All-age IMD notification rates were 84% higher in Aboriginal and Torres Strait Islander people in the 2016–2019 period than in the previous reporting period (2011–2015), and 20% higher for other people.[1] These higher rates were contributed to by the emergence of serogroup W, which caused an outbreak of IMD in Central Australia in 2017, predominantly affecting Aboriginal and Torres Strait Islander children under the age of 15 years,[132] and to a lesser extent by serogroup Y. Notification rates for both serogroup W and Y IMD declined following the progressive implementation of state– and territory-funded meningococcal ACWY vaccination programs from late 2016 and then inclusion under the NIP in early 2019.[133] Evaluation of these programs to identify any gaps in vaccination coverage will be important, along with ongoing monitoring of epidemiology of IMD due to these serogroups.

Notification rates of serogroup C meningococcal disease remained stable and low for the duration of the 2016–2019 period, reflecting the success of the meningococcal C vaccination program implemented under the NIP in 2003.

While serogroup B IMD notification rates in the 2016–2019 period were broadly similar to the 2011–2015 period,[1] the rate in Aboriginal and Torres Strait Islander children and adolescents aged < 15 years remained high, almost tenfold higher in children aged < 5 years and 20-fold in children/adolescents aged 5–14 years, which is similar to previous studies.[134] Higher rates in Aboriginal and Torres Strait Islander children and adolescents are contributed to by social and environmental determinants of health such as overcrowding and tobacco smoke exposure, secondary to a long history of colonisation, dispossession and disadvantage.[135,136] In mid–2020, a national meningococcal B vaccination program for Aboriginal and Torres Strait Islander infants 12 months and younger was commenced under the NIP, along with all individuals of any age with a limited range of specified medical conditions. A catch-up program for Aboriginal and Torres Strait Islander children under the age of two years is available until June 2023. Meningococcal B vaccine is not funded under the NIP for non-Indigenous infants due to the lower rates of disease and lack of cost-effectiveness.[137] However, due to higher incidence locally, meningococcal B vaccination has been state-funded in South Australia for all infants since 2018, and for adolescents since 2019.[138] Recently, a randomised-controlled trial among South Australian adolescents demonstrated no effect of the 4-component meningococcal B vaccine Bexsero on nasopharyngeal carriage of disease-causing meningococci, suggesting that the vaccine does not reduce transmission or contribute to herd immunity.[139,140] Vaccination prior to exposure is therefore needed to ensure direct protection in high-risk groups. Evaluation of the impact of the national and South Australian meningococcal B vaccination programs and ongoing monitoring of serogroup B IMD epidemiology will be important to determine whether eligibility under the NIP needs to be expanded e.g. to older Aboriginal and Torres Strait Islander children and adolescents.

9. Mumps

Relevant vaccine history

1983
- Single dose of MM[i] vaccine funded for all Australian infants at 12 months of age

1984
- Single dose of MM vaccination of Aboriginal and Torres Strait Islander children in the Northern Territory changed from 12 months to 9 months of age

1989
- Single dose of MMR[ii] vaccine recommended and funded on the national schedule at 12 months of age (9 months for Aboriginal and Torres Strait Islander infants in the Northern Territory)

1994
- MMR funded as second dose of mumps-containing vaccine for adolescent females

1996
- MMR funded as second dose of mumps-containing vaccine for all adolescents

1998
- Recommended age for first dose of MMR vaccine for Aboriginal and Torres Strait Islander children in the Northern Territory increased from 9 months to 12 months of age
- Recommended age for second dose of MMR vaccine lowered to 4–5 years

2013
- Second dose of MMR vaccine lowered to 18 months of age, given as MMRV[iii]

Mumps is an acute viral disease caused by a paramyxovirus. Mumps infection involves variable pathology and symptomatology; however, the classical presentation is characterised by fever, painful swelling and inflammation of one or more salivary glands, commonly the parotid glands.[141,142] Between 20% to 40% of cases are sub-clinical.[142] Complications include orchitis, meningitis, encephalitis, hearing loss and pancreatitis.[141,142]

Results

Notification data for mumps are presented for all states and territories for the 2016–2019 period in Table 14. Of the 2,422 cases of mumps in this period, 1,466 (60.5%) were reported as being in Aboriginal and Torres Strait Islander people. The overall all-age notification rate among Aboriginal and Torres Strait Islander people was 37.0 per 100,000 population per year, much higher than the rate among other people (1.0 per 100,000 per year). Notification rates in Aboriginal and Torres Strait Islander people were highest in the 15–24 years age group (73.1 per 100,000 per year for Aboriginal and Torres Strait Islander people versus 1.5 per 100,000 for other people), followed by 5–14 years (58.2 per 100,000 per year versus 0.9 per 100,000 per year) and 25–49 years (49.4 versus 1.2 per 100,000 per year).

Trends in mumps notifications are presented for all states and territories for the 2010–2019 period in Figure 11. Notification rates in Aboriginal and Torres Strait Islander people were low and were similar to rates in other people until they increased sharply in 2015 to 51.4 per 100,000 population per year, peaking at 68.9 per 100,000 per year in 2016. Rates remained elevated in 2017 and 2018 (60.2 and 49.9 per 100,000 per year, respectively) before decreasing to 1.4 per 100,000 per year in 2019. Rates among other people remained low over the same period, reaching a peak of 1.3 per 100,000 population per year in 2017.

i MM: measles and mumps.

ii MMR: measles, mumps and rubella.

iii MMRV: measles, mumps, rubella and varicella.

Table 14: Mumps notifications, Australia (all states and territories), 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Notifications[a] (2016–2019)			
		N	Rate[b]	Rate ratio	95% CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	38	10.07	9.0	5.9–13.6
	Other	66	1.12		
5–14	Aboriginal and Torres Strait Islander	426	58.21	62.1	50.2–77.3
	Other	109	0.94		
15–24	Aboriginal and Torres Strait Islander	465	73.05	48.8	41.0–58.2
	Other	183	1.50		
25–49	Aboriginal and Torres Strait Islander	500	49.36	40.4	35.4–46.1
	Other	411	1.22		
50+	Aboriginal and Torres Strait Islander	37	6.96	12.1	8.3–17.3
	Other	187	0.58		
All ages[c]	Aboriginal and Torres Strait Islander	1,466	36.98	36.9	33.9–40.2
	Other	956	1.00		

a Notifications where the date of diagnosis was between 1 January 2016 and 31 December 2019.

b Average annual age-specific rate per 100,000 population.

c Rates for all ages combined are age-standardised in standard population following the Australian Bureau of Statistics Australian population estimates for 2016.

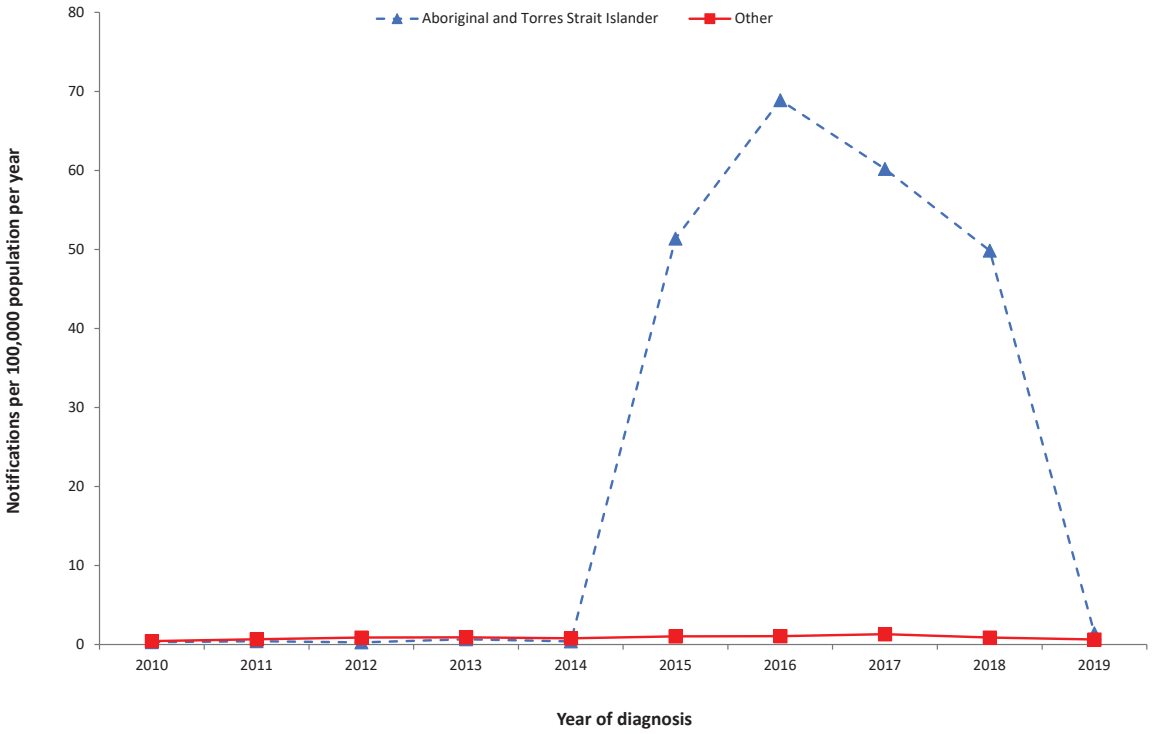
Hospital admission data are presented for all states and territories for the 2016–2019 period in Table 15. There were 472 hospital admissions for mumps, of which 102 (21.6%) were recorded as being in Aboriginal and Torres Strait Islander people. Similar to notifications, the hospitalisation rate was highest among Aboriginal and Torres Strait Islander adolescents and young adults aged 15–24 years (6.1 per 100,000 population per year). Hospitalisation rates were also relatively high in Aboriginal and Torres Strait Islander adults aged 25–49 years (4.9 per 100,000 per year) and children/adolescents aged 5–14 years (3.0 per 100,000 per year). Hospitalisation rates were significantly higher in Aboriginal and Torres Strait Islander people than in other people across all age groups except the 0–4 years and ≥ 50 years age groups, with the all-age rate 7.2 times higher.

Trends in hospitalisations are presented for six states and territories (excluding the Australian Capital Territory and Tasmania) for the 2010–2019 period in Figure 12. Hospitalisation rates in Aboriginal and Torres Strait Islander people were similar to those in other people until 2014 but then increased in 2015 and 2016, peaking in 2017, then decreasing in 2018 and returning to baseline level in 2019. Hospitalisation rates in other people remained stable and low over the entire period.

Over the 2016–2019 period, there were 1–5 deaths[iv] where mumps was reported as an underlying or associated cause of death, all among people aged 50 years or older. There were no deaths recorded as being in Aboriginal and Torres Strait Islander people.

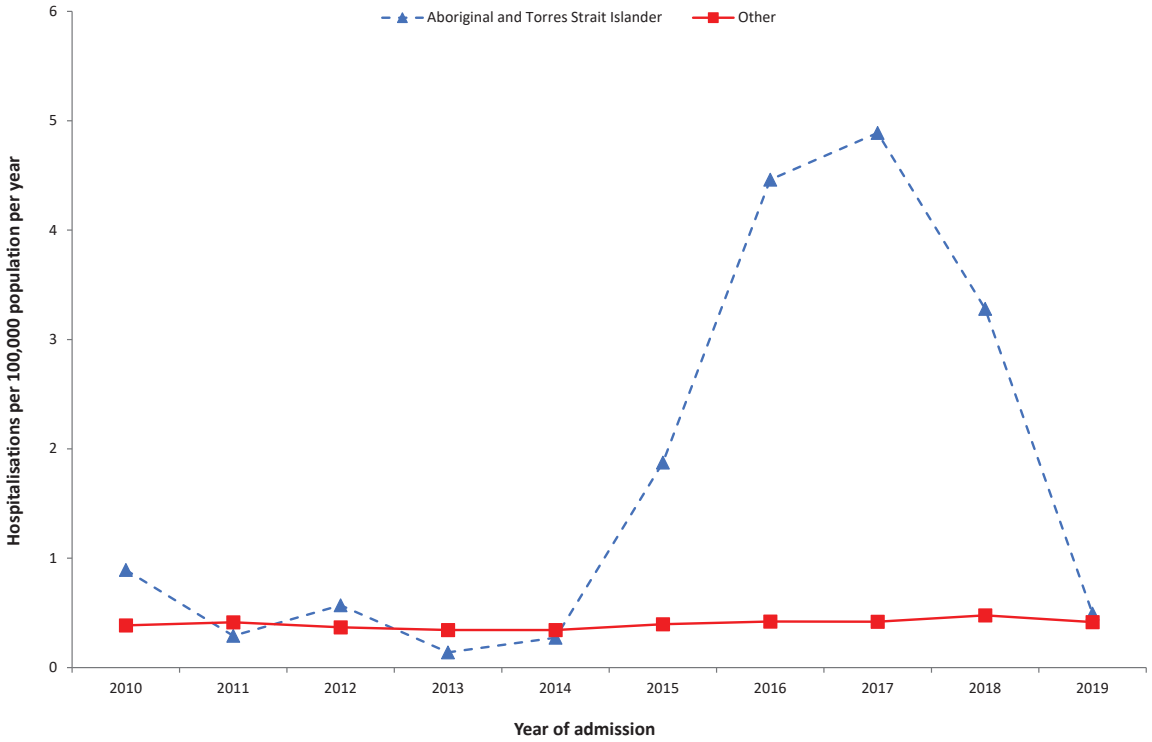
iv To comply with the Australian Coordinating Registry's data release condition that death counts < 6 be suppressed in published reports, counts between 1 and 5 are reported as a range.

Figure 11: Mumps notification rates, Australia (all states and territories), 2010–2019,[a] by Aboriginal and Torres Strait Islander status



a Notifications where the date of diagnosis was between 1 January 2010 and 31 December 2019.

Figure 12: Mumps hospitalisation rates, Australia (selected states and territories),[a] 2010–2019,[b] by Aboriginal and Torres Strait Islander status



a States and territories with satisfactory data quality over the whole time period (refer to Appendix A): the Northern Territory, Queensland, New South Wales, Victoria, South Australia and Western Australia.

b Hospital admissions where the date of admission was between 1 January 2010 and 30 June 2019. 2019 hospitalisation data was annualised.

Table 15: Mumps hospitalisations, Australia (all states and territories), 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Hospitalisations[a] (2016–2019)			
		n	Rate[b]	Rate ratio	95% CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	1–4[c]	0.61	1.0	0.1–3.7
	Other	33	0.64		
5–14	Aboriginal and Torres Strait Islander	19	2.97	5.6	3.1–9.6
	Other	54	0.53		
15–24	Aboriginal and Torres Strait Islander	34	6.12	13.9	8.7–22.1
	Other	47	0.44		
25–49	Aboriginal and Torres Strait Islander	43	4.88	11.3	7.8–16.2
	Other	126	0.43		
50+	Aboriginal and Torres Strait Islander	1–4[c]	0.87	2.2	0.6–5.9
	Other	110	0.39		
All ages[d]	Aboriginal and Torres Strait Islander	102	3.20	7.2	5.7–9.1
	Other	370	0.44		

a Hospital admissions where the date of admission was between 1 January 2016 and 30 June 2019. 2019 hospitalisation data were annualised.

b Average annual age-specific rate per 100,000 population.

c To comply with the AIHW's data release condition that hospitalisation counts < 5 be suppressed in published reports, counts between 1 and 4 are reported as a range.

d Rates for all ages combined are age-standardised to the ABS Australian population estimates for 2016.

Discussion

The mumps notification rate was substantially higher among Aboriginal and Torres Strait Islander people in the 2016–2019 period (37.0 per 100,000 population per year) than in the 2011–2015 period (10.4 per 100,000 per year), but remained low in other people. This is due to a series of large mumps outbreaks, commencing in 2015 and lasting until 2018, with cases predominantly among adolescents and young adults in Aboriginal communities in northern Australia across multiple states and territories.[32,33] Most cases had at least two documented doses of mumps vaccine.[32,143] A similar outbreak in Aboriginal and Torres Strait Islander communities in the Kimberley in Western Australia was reported in 2007–2008, although with only half having received two doses of mumps vaccine.[144,145]

Outbreaks of mumps have been increasingly observed globally among adolescent and young adult populations with high coverage of two doses of mumps-containing vaccine and living in close contact.[32,146–153] Waning immunity and lower vaccine effectiveness has been reported with increasing time since vaccination, particularly among those who completed vaccination more than 10 years prior to disease exposure.[154,155] In 2017, the United States Advisory Committee on Immunization Practices recommended a third dose of mumps-containing vaccine for groups at increased risk for mumps during an outbreak.[156] Australian guidelines now state that adolescents and adults at risk of acquiring mumps in the context of an outbreak can receive a third dose of mumps-containing vaccine.[63]

Immunity against mumps in the Australian population is moderate to high, with 82% demonstrating evidence of antibodies against mumps in a 2012–2013 serosurvey.[157] However, this was lower than similar estimates for measles[158] and rubella,[159] the other components of the MMR vaccine, and is lower than the estimated threshold for herd immunity for mumps of 90–92%[160] Despite this, widespread outbreaks across the population have not been observed. The outbreaks observed among Aboriginal and Torres Strait Islander communities in Australia are likely reflective of a combination of waning immunity from a two-dose vaccination course received a decade or more prior, in a close contact setting with high force of infection.

10. Pertussis

Relevant vaccine history

1942
- Pertussis vaccination programs started in most jurisdictions/territories using three doses of wholecell pertussis vaccine (Pw).

1975
- First national vaccination schedule recommended and funded four DTPw[i] vaccine doses for infants at 3, 4, 5 and 18 months of age.

1994
- Fifth dose of DTPw vaccine added at 4–5 years of age.

1999
- DTPa[ii] vaccine recommended and funded for all five childhood doses.

2003
- 18-month booster ceased.
- Adolescent dTpa[iii] booster introduced; the eligible age group varied in different jurisdictions.

2008–2012
- dTpa vaccine funded temporarily by various jurisdictions for parents/contacts of infants under cocoon strategy during an epidemic. Program timing and eligibility criteria differed between jurisdictions.

2013
- A dose of dTpa vaccine recommended for adults aged > 65 years, if 10 years or more since the last dose.
- dTpa vaccine recommended for women, either during pre-pregnancy planning, during the third trimester or as soon as possible after delivery.

2014–2015
- dTpa vaccine funded for pregnant women by all jurisdictions. Program timing differed between jurisdictions.

2016
- DTPa 18-month booster dose funded.

2017
- The combined DTPa-IPV-Hib vaccine became unavailable for use in Australia.

2018
- dTpa vaccine funded under the NIP for all pregnant women during the third trimester, replacing previous state funding.

Pertussis (whooping cough) is caused by *Bordetella pertussis*, a gram-negative bacterium.[161] The disease is characterised by an insidious onset of minor upper respiratory symptoms, minimal fever and mild cough, with more typical pertussis symptoms of paroxysmal cough starting approximately 1–2 weeks after symptom onset.[161] During this paroxysmal stage, the cough is most severe, characterised by the typical whooping sound, and can be associated with vomiting and exhaustion.[161] Complications include pneumonia, seizures and hypoxic encephalopathy, and can lead to death.[161] The vast majority of deaths occur in infants aged < 6 months, with the case-fatality rate in unvaccinated infants < 6 months of age 0.8%.[63]

Results

In total, 56,963 pertussis notifications were recorded for the 2016–2019 period for all ages combined, with Aboriginal and Torres Strait Islander status reported for 33,701 (59.2%). When restricting analyses to notifications with a reported Aboriginal and Torres Strait Islander status (i.e., omitting those with an unknown status), 5.5% (1,855/33,701) were reported as being in Aboriginal and Torres Strait Islander people. Aboriginal and Torres Strait Islander status completeness was higher at 92.6% (7,054/7,615) among children younger than 5 years of age. Completeness was < 70% in

i DTPw: diphtheria, tetanus and pertussis (whole-cell).

ii DTPa: diphtheria, tetanus and pertussis (acellular).

iii dTpa: diphtheria, tetanus and pertussis (acellular), reduced antigen content.

other age groups (58.7% in 5–14 years; 52.6% in 15–24 years; 48.8% in 25–49 years; 50.8% in ≥ 50 years); therefore, pertussis notification rates by Aboriginal and Torres Strait Islander status are presented for children under the age of 5 years only (see Chapter 1 for further information on Aboriginal and Torres Strait Islander status data completeness).

Pertussis notification data for all states and territories in children younger than 5 years of age for the 2016–2019 period are presented in Table 16. A total of 7,615 notifications were recorded during the reporting period in this age group, 636 of which (8.4%) were in Aboriginal and Torres Strait Islander children. The highest notification rate of pertussis among Aboriginal and Torres Strait Islander children was in the < 6 months age group (323.2 per 100,000 per year), whilst for other Australian children it was in the 6–11 months age group (136.1 per 100,000 per year). The pertussis notification rate was significantly higher among Aboriginal and Torres Strait Islander than other children in all age groups, and particularly in the < 6 months age group (RR: 2.8; 95% CI: 2.3–3.4). Overall, in children under 5 years old, the rate ratio was 1.4 (95% CI: 1.3–1.6).

Table 16: Pertussis notifications, Australia (all states and territories), 2016–2019, for selected age groups by Aboriginal and Torres Strait Islander status

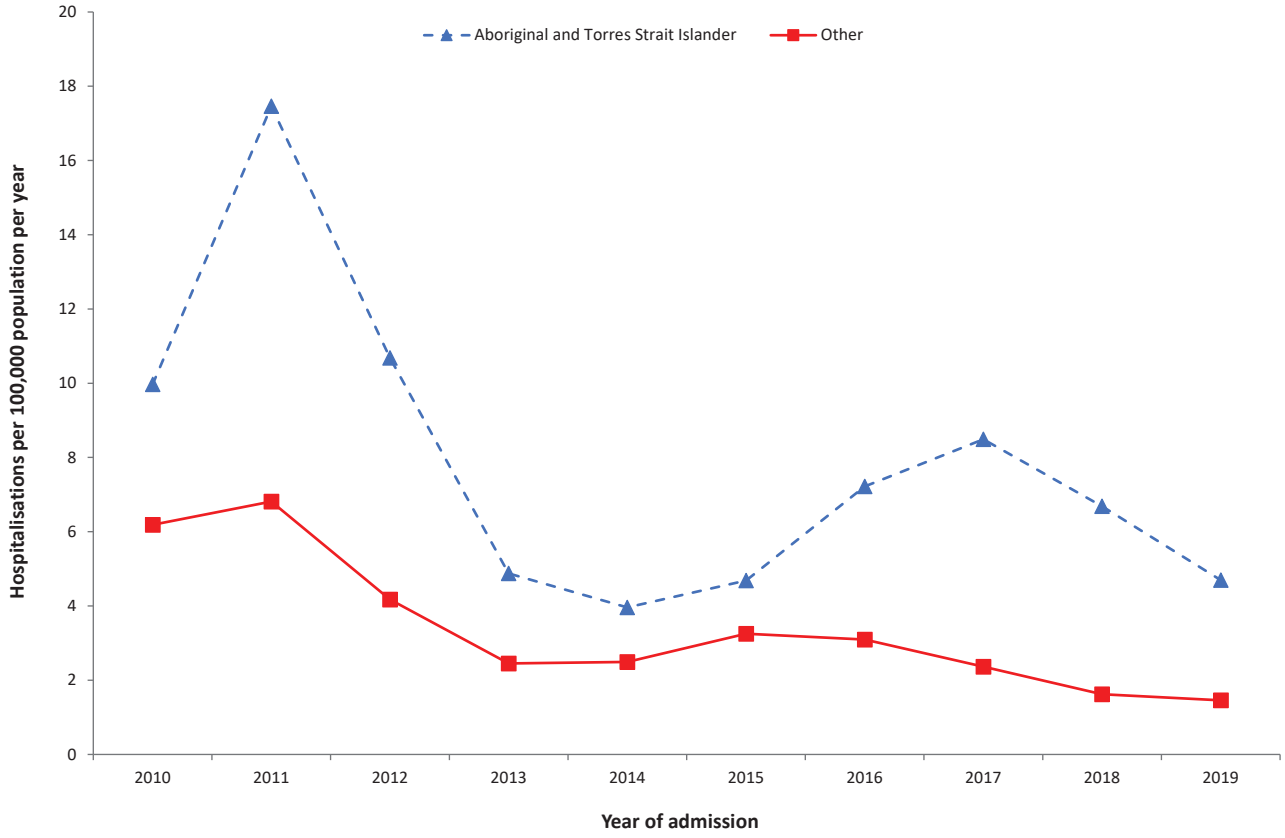
Age group (years)[a]	Aboriginal and Torres Strait Islander status	Notifications[b] (2016–2019)			
		N	Rate[c]	Rate ratio	95% CI for rate ratio
< 1	Aboriginal and Torres Strait Islander	205	267.18	2.1	1.8 – 2.5
	Other	1,440	124.67		
< 6 months	Aboriginal and Torres Strait Islander	124	323.23	2.8	2.3 – 3.4
	Other	660	114.28		
6–11 months	Aboriginal and Torres Strait Islander	84	218.96	1.6	1.3 – 2.0
	Other	786	136.10		
1–4	Aboriginal and Torres Strait Islander	431	143.28	1.2	1.1 – 1.4
	Other	5,539	116.38		
< 5 (total)	Aboriginal and Torres Strait Islander	636	168.46	1.4	1.3– 1.6
	Other	6,979	118.00		

a Data field used to determine the age of children in the 0 –< 6 month age group and the 6 months –< 1 year age group was 'age in weeks.' Data field used to determine the age of children in the < 1, 1–4 and 0–4 years age groups was 'age in years.'

b Notifications where the date of diagnosis was between 1 January 2016 and 31 December 2019.

c Average annual age-specific rate per 100,000 population.

Figure 13: Pertussis hospitalisation rates, Australia (selected states and territories),[a] 2010–2019,[b] by Aboriginal and Torres Strait Islander status



a States and territories with satisfactory data quality 2010–2019; refer to Appendix A (New South Wales, Queensland, South Australia, Western Australia, Northern Territory, Victoria).

b Hospital admissions where the date of admission was between 1 January 2010 and 30 June 2019; 2019 hospitalisation data is annualised.

Hospitalisation data are presented for all states and territories and all age groups for the 2016–2019 period in Table 17. In total, 2,034 hospitalisations for pertussis were recorded, 193 of which (9.5%) were among Aboriginal and Torres Strait Islander people. The highest hospitalisation rates were seen in the < 6 months age group (293.1 per 100,000 per year for Aboriginal and Torres Strait Islander children and 69.1 per 100,000 per year for other children; RR: 4.2; 95% CI: 3.4-5.3). Hospitalisation rates were higher in Aboriginal and Torres Strait Islander than in other people across all age groups, statistically significantly so for the < 6 months, < 1 year, 5–14 year, 25–49 year and ≥ 50 years age groups, with overall rate ratio 2.4 (95% Cl: 2.0–2.8).

Trends in hospitalisation rates for pertussis are presented in Figure 13 for six states and territories (excluding the Australian Capital Territory and Tasmania) for the period 2010 to 2019. The hospitalisation rate among Aboriginal and Torres Strait Islander people peaked at 17.5 per 100,000 population per year in 2011, then declined to 4.0 per 100,000 per year in 2014, before increasing to 8.5 per 100,000 per year in 2017 and declining again to 4.7 per 100,000 per year in 2019. Hospitalisation rates among other people also peaked in 2011 at 6.8 per 100,000 per year and declined to reach 1.5 per 100,000 per year in 2019.

There were ten deaths reported in Australia for the period 2016–2019 with pertussis as the

Table 17: Pertussis hospitalisations, Australia (all states and territories), 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Hospitalisations[a] (2016–2019)			
		n	Rate[b]	Rate ratio	95%CI for rate ratio
< 1	Aboriginal and Torres Strait Islander	110	164.49	3.6	2.9 – 4.4
	Other	463	45.68		
< 6 months	Aboriginal and Torres Strait Islander	98	293.10	4.2	3.4 – 5.3
	Other	350	69.06		
6–11 months	Aboriginal and Torres Strait Islander	NP[c]	35.89	1.6	0.8 – 2.9
	Other	113	22.30		
1–4	Aboriginal and Torres Strait Islander	20	7.61	1.5	0.9 – 2.4
	Other	209	5.02		
5–14	Aboriginal and Torres Strait Islander	16	2.50	1.8	1.01 – 3.1
	Other	140	1.38		
15–24	Aboriginal and Torres Strait Islander	1-5[c]	0.72	1.7	0.5 – 4.7
	Other	45	0.42		
25–49	Aboriginal and Torres Strait Islander	22	2.49	3.1	1.9 – 4.8
	Other	237	0.81		
50+	Aboriginal and Torres Strait Islander	21	4.56	1.7	1.1 – 2.7
	Other	747	2.64		
All ages[d]	Aboriginal and Torres Strait Islander	193	5.35	2.4	2.0 – 2.8
	Other	1,841	2.24		

a Hospital admissions where the date of admission was between 1 January 2016 and 30 June 2019. 2019 hospitalisation data were annualised.

b Average annual age-specific rate per 100,000 population.

c To comply with the AIHW's data release condition that hospitalisation counts < 5 be suppressed in published reports, counts between 1 and 4 are reported as a range; other cell counts may be reported as NP (not published) to avoid potential for back calculation of counts < 5.

d Rates for all ages combined are age-standardised to the ABS Australian population estimates for 2016.

underlying or associated cause of death. Of these, between 1–5 deaths[iv] were recorded as being in Aboriginal and Torres Strait Islander people.

iv To comply with the Australian Coordinating Registry's data release condition that death counts < 6 be suppressed in published reports, counts between 1 and 5 are reported as a range.

Discussion

Pertussis notification rates in infants aged < 1 year were approximately 20% lower in the 2016–2019 period compared to the 2011–2015 period, for both Aboriginal and Torres Strait Islander and other infants, with hospitalisation rates 36% lower in Aboriginal and Torres Strait Islander infants and 60% lower in other infants.[1] However, our analysis of rates in infants aged < 6 months, the age group most at risk of severe

pertussis, showed a threefold higher notification rate and fourfold higher hospitalisation rate in the 2016–2019 period in Aboriginal and Torres Strait Islander infants than in other infants. To address these high rates, the focus should be on improving timeliness of vaccination, particularly of the first two vaccine doses due at 2 and 4 months of age, and uptake of maternal pertussis vaccination during pregnancy. In 2019, the proportion of Aboriginal and Torres Strait Islander infants receiving their second DTPa vaccine on time (within 1 month of due date) was 11 percentage points lower than other children (80.9% versus 91.8%, respectively; see vaccination coverage chapter), consistent with previous studies.[162–164] Initiatives such as the NSW Aboriginal Immunisation Healthcare Worker program, which has contributed to improved timeliness of vaccination in NSW,[164] may help reduce pertussis notification and hospitalisation rates among Aboriginal and Torres Strait Islander infants.

Maternal dTpa vaccination in the third trimester of pregnancy is also effective at reducing the burden of pertussis in young infants.[165–167] Our results, along with other studies,[166–168] highlight the importance of maternal vaccination for pregnant Aboriginal and Torres Strait Islander women. State/territory-funded funded pertussis immunisation programs for pregnant women were progressively introduced from 2014 with inclusion on the NIP in July 2018. Analyses have shown progressive reductions in overall pertussis notification rates in the < 2 months age group in each year from 2015 to 2018, suggesting impact of maternal pertussis immunisation programs.[169] The limited data available on maternal dTpa vaccine uptake suggest it is lower among Aboriginal and Torres Strait Islander than among other women.[166,170,171] It will therefore be important to monitor maternal vaccination coverage in Aboriginal and Torres Strait Islander women, and disease rates in Aboriginal and Torres Strait Islander infants, to ensure that the benefits of the program are equitably distributed.

While pertussis hospitalisation rates are much lower in older age groups than in infants, pertussis can lead to serious or prolonged disease in any age group, particularly among adults aged ≥ 65 years.[172,173] Maintaining high rates of coverage with pertussis-containing vaccines, according to current Australian guidelines,[63] is important both for direct protection and to reduce onward transmission to infants, who most commonly acquire infection from parents, caregivers and household or family contacts.[174,175]

11. Pneumococcal disease

Relevant vaccine history

1986
- 23vPPV[i] funded for children aged over 2 years with increased risk of pneumococcal disease or complications, due to specified underlying conditions, living in north Western Australia and the Northern Territory.

1991–1993
- 23vPPV funded for all Aboriginal and Torres Strait Islander people aged over 2 years living in north Western Australia.

1995–1996
- 23vPPV funded for Aboriginal and Torres Strait Islander people aged ≥ 50 years in the Northern Territory (1995) and Far North Queensland (1996, including people aged 15–49 years with underlying conditions).

1997
- 23vPPV recommended for all Aboriginal and Torres Strait Islander adults aged > 50 years.

1998
- 23vPPV funded for Aboriginal and Torres Strait Islander adults aged > 50 years and other adults aged ≥ 65 years in Victoria.

1999
- 23vPPV funded nationally for all Aboriginal and Torres Strait Islander adults aged ≥ 50 years or aged 15–49 years with underlying conditions.

2000
- 23vPPV eligibility in the Northern Territory changed to all Aboriginal and Torres Strait Islander people aged ≥ 15 years. 23vPPV eligibility in central Australia changed to all Aboriginal and Torres Strait Islander children aged 2–5 years.

2001
- 7vPCV[ii] funded for all Aboriginal and Torres Strait Islander infants in a 3+0 schedule and children with underlying at risk conditions in a 3+1 schedule. A booster dose of 23vPPV was funded in the Northern Territory, Queensland, South Australia and Western Australia (at age 18/24 months).

2005
- 7vPCV funded for all other children (in a 3+0 schedule) and 23vPPV funded for all adults aged ≥ 65 years.

2009
- The Northern Territory replaced 7vPCV and 23vPPV in the routine childhood vaccination schedule with 10vPCV[iii] using a 3+1 schedule.

2011
- 13vPCV[iv] replaced all other pneumococcal vaccines for all children aged < 2 years.

2012
- A fourth dose (as a booster) of 13vPCV at 12–18 months of age recommended and funded for Aboriginal and Torres Strait Islander children living in the Northern Territory, Queensland, South Australia and Western Australia to replace the 23vPPV booster.

2013
- Advice provided that 1st dose of 13vPCV could be given as early as 6 weeks of age along with other first dose primary course vaccines recommended at the 2 month time point.
- Upper age for which 13vPCV registered for use in children extended to 17 years.

2014
- Age for which 13vPCV registered for use extended in adults (now registered for use in children from 6 weeks of age and adults).

2018
- Schedule for routine childhood vaccination with 13vPCV changed from 3+0 at 2, 4 and 6 months of age to 2+1 at 2, 4 and 12 months of age. Schedule remained as 2, 4, 6 and 12 months (3 + 1) for Aboriginal and Torres Strait Islander children living in the Northern Territory, South Australia, Queensland and Western Australia, and children with underlying conditions.

i 23vPPV: 23-valent pneumococcal polysaccharide vaccine.

ii 7vPCV: 7-valent pneumococcal conjugate vaccine.

iii 10vPCV: 10-valent pneumococcal conjugate vaccine.

iv 13vPCV: 13-valent pneumococcal conjugate vaccine.

Pneumococcal disease is caused by the bacterium *Streptococcus pneumoniae* (also known as pneumococcus). There are around 100 different serotypes of pneumococcus.[176] Pneumococci colonise the upper respiratory tract in adults and, more heavily and often, in children. Pneumococci can spread locally into the upper or lower respiratory tract, causing pneumonia, otitis media or sinusitis. Pneumococci can also enter the blood stream and cause invasive disease such as meningitis, bacteraemia and, less commonly, infection of other sites such as joints and pleural or peritoneal fluid.[177] Invasive pneumococcal disease (IPD) is diagnosed through the detection of *S. pneumoniae* in the blood, cerebrospinal fluid or another sterile site.[177]

Results

IPD notification rates are presented for all states and territories for the 2016–2019 period in Table 18. There were 7,872 notifications in the reporting period with 916 (11.6%) reported as being in Aboriginal and Torres Strait Islander people. The overall (all ages combined) notification rate among Aboriginal and Torres Strait Islander people, at 37.3 per 100,000 per year, was substantially higher than the rate among other people at 7.2 per 100,000 per year (RR: 5.2; 95% CI: 4.9–5.5). The highest age-specific notification rates were seen in Aboriginal and Torres Strait Islander people in the ≥ 50 years (65.5 per 100,000 per year), 0–4 years (32.8 per 100,000 per year) and 25–49 years (32.4 per 100,000 per year) age groups. Rates were significantly higher in Aboriginal and Torres Strait Islander than other people across all age groups.

Trends in IPD notifications, by age and Aboriginal and Torres Strait Islander status, are presented for all states and territories for the 2010–2019 period in Figure 14. Rates of IPD notifications among Aboriginal and Torres Strait Islander children aged 0–4 years peaked in 2011 at 56.5 per 100,000 per year, and then remained between 28.7 and 40.3 per 100,000 per year for the following eight years. Among other children aged 0–4 years, rates decreased from 2010 (18.4 per 100,000 per year) to 2012 (11.4 per 100,000 per year) and then increased, reaching 19.5 per 100,000 per year in 2019. The lowest notification rates were in the 5–49 year age group, for both Aboriginal and Torres Strait Islander and other people. Whilst the IPD notification rate in other people in this age group stayed relatively stable over the 10-year period at around 3.0 per 100,000 per year, the rate among Aboriginal and Torres Strait Islander people aged 5–49 years peaked in 2011 at 37.4 per 100,000 and ranged between 13.6 and 22.1 per 100,000 per year from 2013 to 2019. IPD notification rates in Aboriginal and Torres Strait Islander adults aged ≥ 50 years decreased from 65.7 per 100,000 per year in 2012 to 47.8 per 100,000 per year in 2014, then progressively increased, reaching 73.3 per 100,000 per year in 2019. By comparison, the rate in other adults aged ≥ 50 years stayed relatively stable over the 10-year period, ranging between 10.7 and 14.5 per 100,000 per year.

Pneumococcal vaccines contain a varying number of serotypes (seven in 7-valent pneumococcal conjugate vaccine [7vPCV], an additional six in 13-valent conjugate vaccine [13vPCV] and an additional 11 (without serotype 6A found in 13vPCV) in 23-valent polysaccharide vaccine [23vPPV]). Serotype data were available for 91.9% of IPD notifications (7,231/7,872). IPD notification rates by Aboriginal and Torres Strait Islander status and serotypes covered by vaccines are shown by age group for two 4-year periods (2012–2015 and 2016–2019) in Figure 15; the distribution of serotypes causing IPD, by Aboriginal and Torres Strait Islander status, is presented in Figure 16 for the 2016–2019 period.

Notification rates per 100,000 per year for IPD caused by serotypes in 7vPCV were higher in the 2016–2019 period than the 2012–2015 period in all three age groups assessed, in both Aboriginal and Torres Strait Islander people (by 49% in 0–4 years; 94% in 5–49 years; and 22% for ≥ 50 years) and in other people (77% for 0–4 years; 33% for 5–49 years; and 43% for ≥ 50 years). In the 2016–2019 period, serotype 4 was the most common 7vPCV serotype causing IPD

Table 18: Invasive pneumococcal disease notification rates, Australia (all states and territories), 2016–2019, by Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Notifications[a] (2016–2019)			
		N	Rate[b]	Rate ratio	95% CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	124	32.84	1.9	1.5–2.3
	Other	1,034	17.48		
5–14	Aboriginal and Torres Strait Islander	45	6.15	2.3	1.7–3.2
	Other	307	2.64		
15–24	Aboriginal and Torres Strait Islander	71	11.15	9.7	7.2–13.0
	Other	141	1.15		
25–49	Aboriginal and Torres Strait Islander	328	32.38	10.1	8.9–11.4
	Other	1,078	3.21		
> 50	Aboriginal and Torres Strait Islander	348	65.46	4.8	4.3–5.4
	Other	4,396	13.54		
All ages[c]	Aboriginal and Torres Strait Islander	916	37.32	5.2	4.9–5.5
	Other	6,956	7.21		

a Notifications where the date of diagnosis was between 1 January 2016 and 31 December 2019.

b Average annual age-specific rate per 100,000 population.

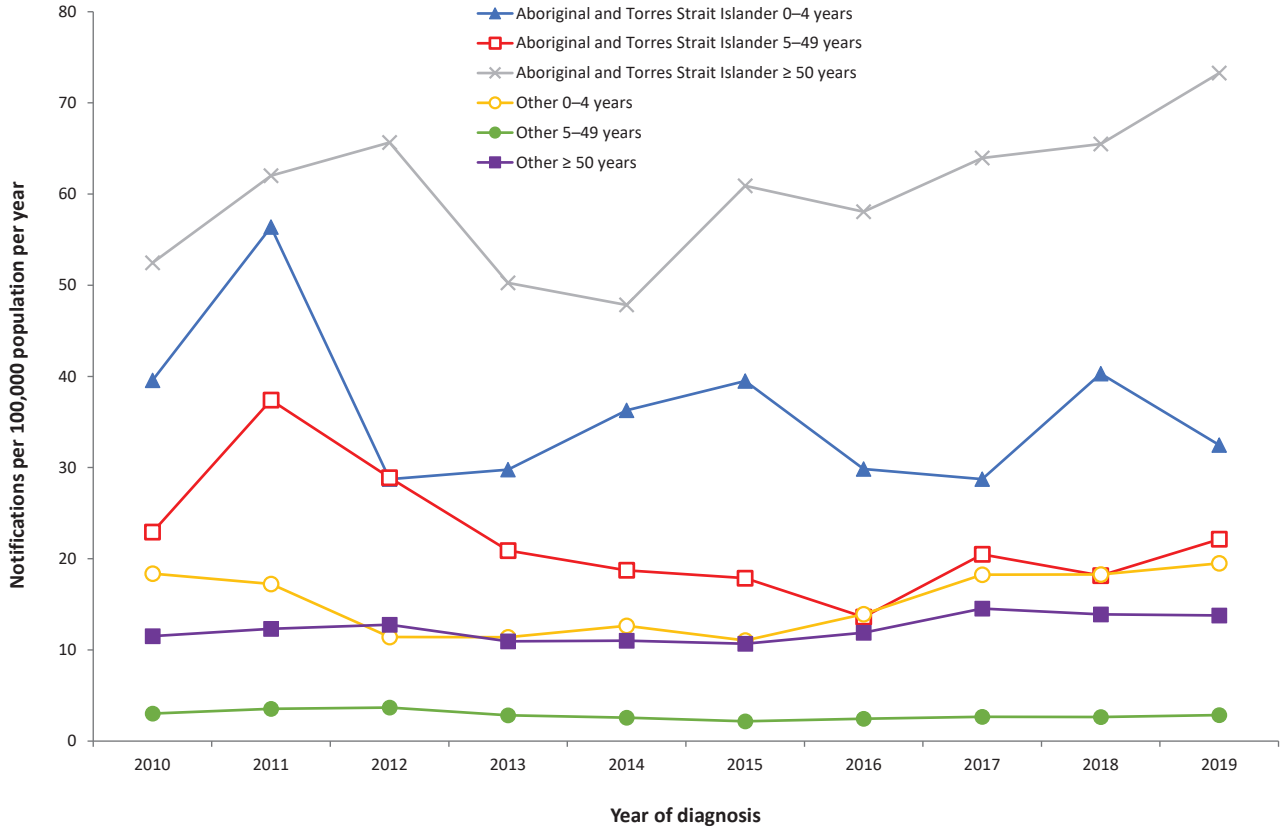
c Rates for all ages combined are age-standardised to the Australian Bureau of Statistics Australian population estimates for 2016.

in Aboriginal and Torres Strait Islander people (6.1% of cases vs 0.7% in other Australians). Serotype 4 caused no IPD notifications among Aboriginal and Torres Strait Islander children aged < 5 years (0% in other children); 10.4% in Aboriginal and Torres Strait Islander people aged 5–49 years (1.0% in other people); and 2.5% in Aboriginal and Torres Strait Islander adults aged ≥ 50 years (0.7% in other adults) (data not shown). Serotype 19F was the next most common 7vPCV serotype causing IPD in Aboriginal and Torres Strait Islander people (3.7% of cases vs 7.8% in other Australians). When analysing serotype prevalence in Aboriginal and Torres Strait Islander people by age group, serotype 19F was the 7vPCV serotype that caused most IPD in Aboriginal and Torres Strait Islander children aged < 5 years (9.5% vs 11.4% in other children) and in Aboriginal and Torres Strait Islander adults aged ≥ 50 years (3.4% vs 6.9%) (data not shown). Serotype 19F prevalence in Aboriginal and Torres Strait Islander children aged < 5 years increased from 1.2% in the 2011–2015 period.

In the 0–4 years age group, the notification rate of IPD caused by serotypes in 13vPCV but not in 7vPCV (13v–non-7v) was 38% lower in the 2016–2019 period than the 2012–2015 period in Aboriginal and Torres Strait Islander children, but 28% higher in other children in this age group. In the 5–49 years age group, the notification rate of 13v–non-7v IPD was 54% lower in Aboriginal and Torres Strait Islander people and 39% lower in other people, and in adults aged > 50 years there was little change in either group.

In the 2016–2019 period, serotype 3 was the most common 13v-non-7v serotype, causing 10.7% of IPD cases among Aboriginal and Torres Strait Islander people and 16.3% among other Australians. Among Aboriginal and Torres Strait Islander people, serotype 3 was the most

Figure 14: Invasive pneumococcal disease notification rates, Australia (all states and territories), 2010–2019,[a] by age and Aboriginal and Torres Strait Islander status

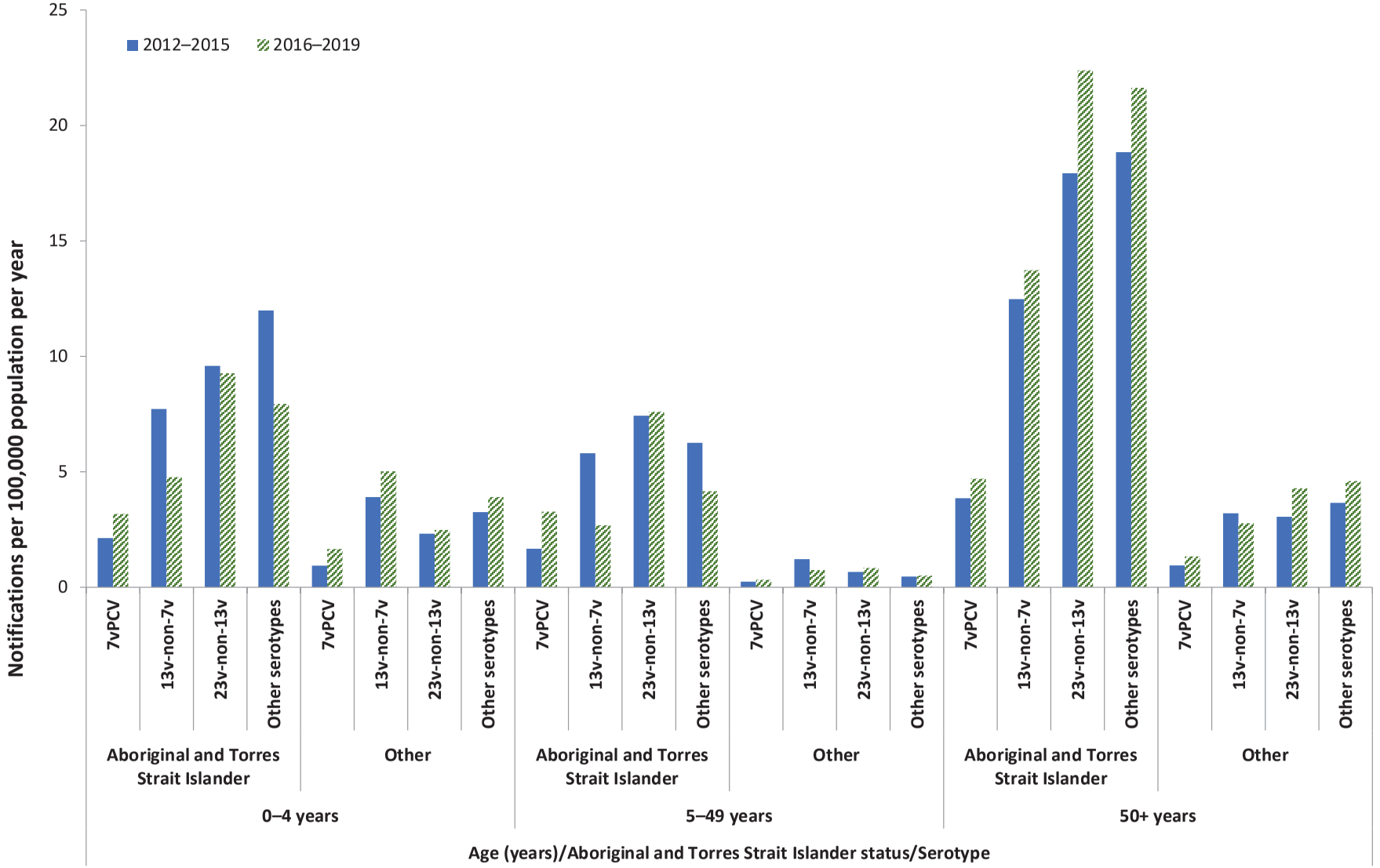


a Notifications where the date of diagnosis was between 1 January 2010 and 31 December 2019.

common 13v-non7v type across the three age groups. The 13v-non-7v serotype 7F was identified in 6.0% of IPD cases in Aboriginal and Torres Strait Islander people and 1.8% of other Australians. Serotype 7F caused no IPD notifications among Aboriginal and Torres Strait Islander children aged < 5 years (0.1% in other children); 7.1% in Aboriginal and Torres Strait Islander people aged 5–49 years (4.9% in other people); and 6.5% in Aboriginal and Torres Strait Islander adults aged ≥ 50 years (1.1% in other adults) (data not shown). Serotype 19A was more common among IPD cases in other people (6.9%) than among cases in Aboriginal and Torres Strait Islander people (1.3%).

Notification rates of IPD caused by serotypes in 23vPPV but not in 13vPCV (23v–non-13v) were similar in the 2016–2019 period compared to the 2012–2015 period in Aboriginal and Torres Strait Islander and other people aged 0–4 years and 5–49 years but were higher in adults aged > 50 years, by 25% and 40%, respectively. In the 2016–2019 period, serotype 8 was the most common 23v-non13vPCV type among Aboriginal and Torres Strait Islander people, causing 12.1% of IPD (3.0% in other Australians). The prevalence of serotype 8 among Aboriginal and Torres Strait Islander people was 5.3% in children aged < 5 years (0.5% in other children), 16.6% in those aged 5–49 years (6.3% in other people) and 8.7% among adults aged ≥ 50 years (2.3% in other adults). The prevalence of other 23v-non-13v serotypes 12F and 10A was higher among Aboriginal and Torres Strait Islander people overall (4.5% and 4.1%, respectively) than among other people (1.5% and 1.4%, respectively). Other prevalent serotypes included in 23vPPV but not 13vPCV included 22F (6.2% of IPD in Aboriginal and Torres Strait Islander people and 8.5% in other people), 9N (4.7% and 7.3%, respectively) and 10A (4.1% and 1.4%, respectively).

Figure 15: Invasive pneumococcal disease notification rates for four vaccine serotype groups, Australia (all states and territories), 2012–2015[a] compared with 2016–2019,[b] by age and Aboriginal and Torres Strait Islander status[c]



a Notifications where the date of diagnosis was between 1 January 2012 and 31 December 2015.
b Notifications where the date of diagnosis was between 1 January 2016 and 31 December 2019.
c Excludes cases with unknown serotype.

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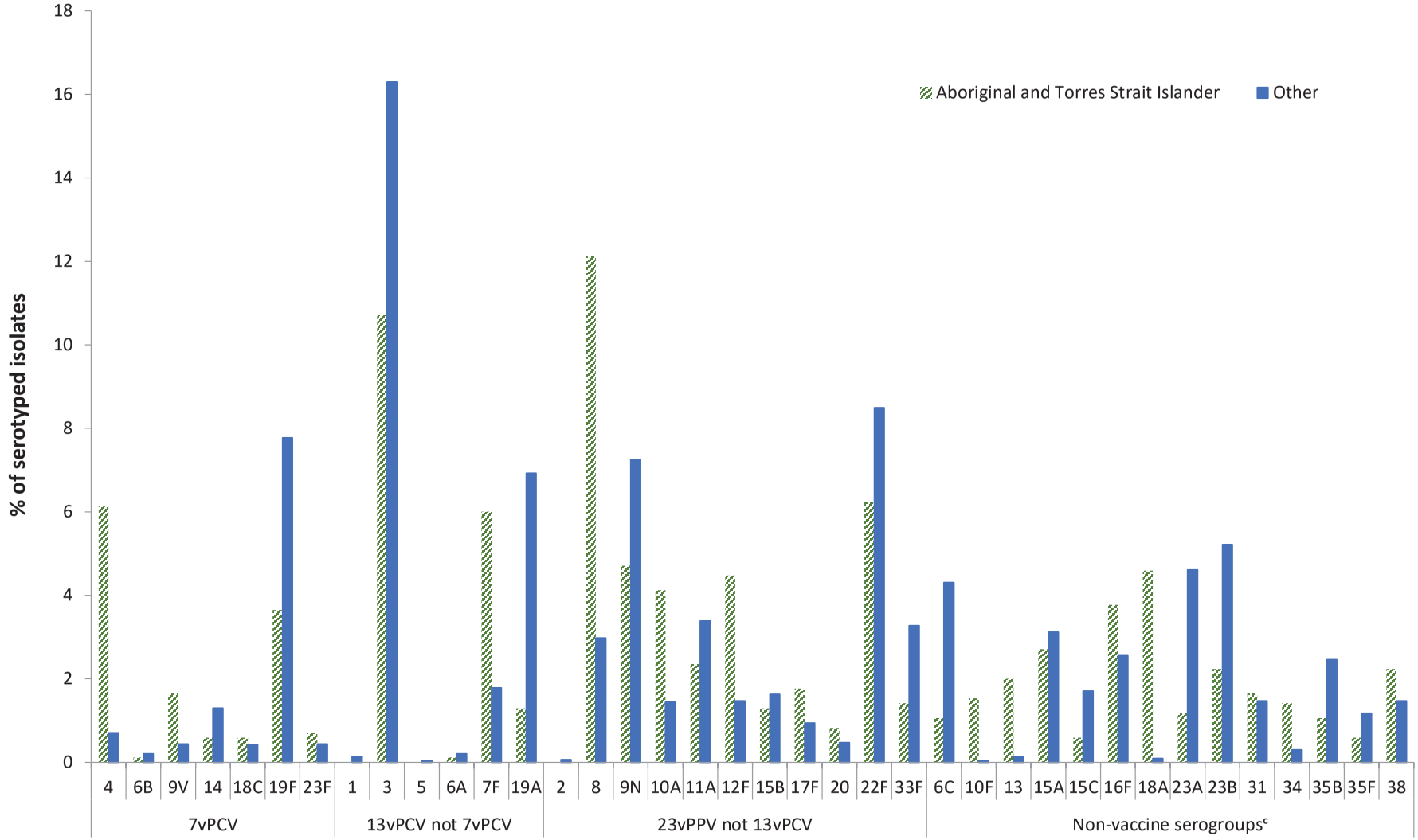
Figure 16: Percentage of IPD attributed to pneumococcal serotypes[a] grouped by vaccine type, Australia (all states and territories), 2016–2019,[b] by Aboriginal and Torres Strait Islander status



a Excludes cases with unknown subtype.
b Notifications where the date of diagnosis was between 1 January 2016 and 31 December 2019.
c Other non-vaccine serogroups that were < 1% prevalent among both Aboriginal and Torres Strait Islander people and other Australian people are not shown. The total prevalence of "other" non-vaccine serogroups was 2.5% among Aboriginal and Torres Strait Islander people and 3.3% among other Australian people.

Notification rates of IPD due to 'other' (non-vaccine) serotypes were 34% lower in the 2016–2019 period than in the 2012–2015 period among Aboriginal and Torres Strait Islander people in the 0–4 and 5–49 years age groups, but higher in other people of the same age groups (20% and 9%, respectively). In the > 50 years age group, notification rates of IPD caused by 'other' serotypes were 15% higher among Aboriginal and Torres Strait Islander people and 26% higher in other Australians. In the 2016–2019 period, non-vaccine serotypes accounted for 29.1% of notifications among Aboriginal and Torres Strait Islander people; the most common such serotype was 18A (4.6%, compared to 0.1% in other people).

Hospitalisation data for IPD are not presented due to limitations in identifying cases of IPD using discharge diagnosis codes.

There were 218 deaths reported in Australia in the 2016–2019 period with pneumococcal disease recorded as underlying or associated cause of death, of which nine (4.1%) were recorded as being in Aboriginal and Torres Strait Islander people.

Discussion

The IPD notification rate among Aboriginal and Torres Strait Islander people was lower in the 2016–2019 period than the 2011–2015 period[1] in those aged < 50 years: 23% lower in 0–4 years, 62% in 5–14 years, 16% lower in 15–24 years and 21% in 25–49 years; but was 4% higher in the ≥ 50 years age group. However, rates among Aboriginal and Torres Strait Islander people in the 2016–2019 period remained significantly higher than other Australians across all age groups: fivefold higher overall (all ages combined) and tenfold higher in those aged 15–49 years.

The current reporting period (2016–2019) reflects IPD incidence after 5 years of 13vPCV use in children in Australia with high coverage (see vaccination coverage chapter). From 2012 onwards, Aboriginal and Torres Strait Islander children in the Northern Territory, South Australia, Western Australia and Queensland have been offered an additional dose (booster) of 13vPCV above the 3 doses funded for all other children. The coverage of this fourth dose varied across those states between 53.1% (Queensland) and 92.6% (the Northern Territory) in 2019 (see Chapter 15: vaccination coverage). Of note the proportion of IPD due to 13v-non-7v serotypes was substantially lower in Aboriginal and Torres Strait Islander people aged < 50 years in the 2016–2019 period than the 2012–2015 period. This likely reflects vaccine impacts, in particular resolution of the 2010–2013 outbreak of IPD due to serotype 1 (a 13v-non-7v serotype) in Aboriginal and Torres Strait people in central and northern Australia,[178] with no cases of serotype 1 in Aboriginal and Torres Strait Islander people of any age in the 2016–2019 period.

Since the introduction of 7vPCV, and subsequently that of 13vPCV in 2011, into the childhood vaccination program, there has been a decline in 7vPCV type IPD in all age groups.[179–182] However, the rates of IPD caused by 7vPCV serotypes in this reporting period increased in children, primarily due to an increase in serotype 19F. Lower effectiveness of 13vPCV than of 7vPCV against serotype 19F is evident in increasing breakthrough cases due to this serotype seen since 2013 in children from the second year of life.[183] It is anticipated that the change in the standard NIP schedule from 3+0 (3 primary doses with no booster) to 2+1 (2 primary doses with a booster) from mid-2018 will improve protection.

The persistent tenfold higher incidence of IPD in Aboriginal and Torres Strait Islander adults aged 25–49 years than among other adults aged 25–49 years, and fivefold higher incidence in adults aged ≥ 50 years, is likely contributed to by the high prevalence of underlying medical conditions among Aboriginal and Torres Strait Islander adults.[184] The expansion in 2020 of NIP funding for 13vPCV and 23vPPV vaccination for anyone with underlying risk factors, and to all Aboriginal and Torres Strait Islander adults from 50 years of age,[125] should help reduce IPD rates.

However, little data on uptake is available and previous data suggests it may be suboptimal. The Australian Technical Advisory Group on Immunisation has identified pneumococcal vaccination for Aboriginal and Torres Strait Islander adults aged < 50 years as an area of priority to develop policies to enable equitable access to NIP-funded vaccines and reliable systems to capture vaccination uptake.[185]

Serotypes covered by pneumococcal vaccines continue to cause IPD in both Aboriginal and Torres Strait Islander people and other Australians. The most common serotype causing IPD in the 2016–2019 period was serotype 3, a 13v-non-7v serotype. Previous Australian studies showed little change in serotype 3 IPD incidence in children following introduction of 13vPCV onto the NIP,[179,186] unlike in the USA and UK where decreases were observed.[187–189] The effectiveness of current vaccines included in the National Immunisation Program in Australia against serotype 3 have been shown to be suboptimal, with an observed increase in empyema hospitalisations and the increase of pneumococcal serotype 3 in empyema.[189,190] Trials of 13vPCV suggest relative lower immunogenicity against serotype 3 to be an inherent property of the vaccine.[191,192]

Two higher valency PCVs, 15vPCV and 20vPCV, have been developed.[193,194] In 2021, the Therapeutic Goods Administration registered 15vPCV for use in adults aged ≥ 18 years. Availability of these newer vaccines would enable better matching to prevalent serotypes, as some of the additional serotypes included, such as 8, 12F and 22F, are responsible for a substantial proportion of IPD in Aboriginal and Torres Strait Islander people. Continued surveillance is important to detect any changes in serotype distribution.

Despite two decades of PCV use, IPD incidence remains significantly higher across all age groups among Aboriginal and Torres Strait Islander people. Pneumococcal carriage density in Aboriginal and Torres Strait Islander children remains high, with wide serotype diversity,[195] which—along with social and environmental factors such as overcrowding and tobacco smoke exposure, secondary to a long history of colonisation, dispossession and disadvantage[135,136]—promotes transmission. While improving vaccine coverage and timeliness will maximise the impact of vaccines in Aboriginal and Torres Strait Islander people, addressing the social and environmental determinants of health will also be key to optimising prevention of pneumococcal disease.

12. Rotavirus

Relevant vaccine history

2006
- Vaccination recommended and funded for Northern Territory infants using monovalent rotavirus vaccine (Rotarix®) in a two-dose schedule (2 and 4 months of age)
- Vaccination recommended for all Australian infants, using either monovalent rotavirus vaccine, Rotarix® (two doses) or pentavalent rotavirus vaccine, RotaTeq® (three doses)

2007
- National funded immunisation program commenced mid-year. NSW, NT, ACT, WA and Tas using two-dose schedule of monovalent rotavirus vaccine, Rotarix® (2 and 4 months of age). Vic, SA and Qld using three-dose schedule of pentavalent rotavirus vaccine, RotaTeq® (2,4 and 6 months of age)

2009
- WA changed from using three-dose schedule of monovalent vaccine to using a three-dose schedule using pentavalent rotavirus vaccine (RotaTeq®)

2013
- Updated advice that first dose of rotavirus vaccine can be administered as early as 6 weeks of age

2017
- Qld, SA, Vic and WA changed from using a three-dose schedule using pentavalent rotavirus vaccine (RotaTeq®) to two-dose schedule monovalent rotavirus vaccine (Rotarix®). All states now using the same two-dose monovalent rotavirus vaccine schedule

Rotavirus is the most common cause of viral gastroenteritis in children worldwide.[196] Infection can be asymptomatic or symptomatic, with presentation ranging from to mild diarrhoea to severe gastroenteritis. The severity of infection is primarily dependent on age and previous exposure to rotavirus, with infections more likely to be severe in first infections in children aged 3–24 months.[197]

Results

As rotavirus became nationally notifiable from 1 July 2018, notification data are included in this report for the first time. A total of 7,911 rotavirus notifications were recorded for all age groups combined between 1 July 2018 and 31 December 2019 across all states and territories. Aboriginal and Torres Strait Islander status was reported for 5,513 cases (69.7%), with a large variation across jurisdictions (for more detail see Chapter 1). When restricting analyses to notifications with a reported Aboriginal and Torres Strait Islander status (i.e. omitting those with an unknown status), 499 rotavirus notifications (9.1%) were among Aboriginal and Torres Strait Islander people.

Notification data are presented in Table 19 for children aged < 5 years in states and territories (Australian Capital Territory, Northern Territory, Queensland, South Australia, Tasmania and Western Australia) which had adequate completeness (≥ 70%) for Aboriginal and Torres Strait Islander status in this age group for the period 1 July 2018 to 31 December 2019. A total of 2,444 notifications were recorded in the six states and territories for the 18-month period, of which 342 (14.0%) were recorded as being in Aboriginal or Torres Strait Islander children. The highest age-specific notification rate of rotavirus among both Aboriginal and Torres Strait Islander and other children was in the < 6 months age group (1,476.0 per 100,000 per year and 954.4 per 100,000 per year). The rotavirus notification rate was significantly higher among Aboriginal and Torres Strait Islander children than among other children in all age groups, particularly in the 6 months to 1

Table 19: Rotavirus notifications, Australia (selected states and territories),[a] 1 July 2018 to 31 December 2019,[b] for selected age groups by Aboriginal and Torres Strait Islander status

Age group[c] (years)	Aboriginal and Torres Strait Islander Status	Notifications (1 July 2018 to 31 December 2019)			
		N	Rate[d]	Rate ratio	95% CI for rate ratio
0 –< 1	Aboriginal and Torres Strait Islander	175	1,033.2	1.8	1.5–2.1
	Other	1,006	577.0		
0 –< 6 months	Aboriginal and Torres Strait Islander	125	1,476.0	1.6	1.3–1.9
	Other	832	954.4		
6 months –< 1 year	Aboriginal and Torres Strait Islander	51	602.2	3.0	2.1–4.1
	Other	177	203.0		
1–4	Aboriginal and Torres Strait Islander	167	253.3	1.7	1.4–2.0
	Other	1,096	148.2		
0–4 (total)	Aboriginal and Torres Strait Islander	342	412.8	1.8	1.6–2.0
	Other	2,102	230.0		

a Australian Capital Territory, Northern Territory, Queensland, South Australia, Tasmania and Western Australia.

b Notifications where the date of diagnosis was between 1 July 2018 and 31 December 2019. 2018 notification data was annualised.

c Data fields used to determine the age of children in the 0 –< 6 month age group and the 6 months –< 1 year age group was 'age in weeks.' Data fields used to determine the age of children in the < 1, 1–4 and 0–4 years age groups was 'age in years.'

d Average annual age-specific rate per 100,000 population.

year age group (RR: 3.0; 95% CI: 2.1–4.1). The overall rate ratio in children aged < 5 years was 1.8 (95% CI: 1.6–2.0).

Data on hospital admissions with rotavirus as one of the coded diagnoses are presented for all states and territories for the 2016–2019 period in Table 20. Of the total 4,145 hospitalisations coded as rotavirus in all ages, 518 (12.4%) were recorded as being in Aboriginal or Torres Strait Islander people. The highest hospitalisation rates were in Aboriginal and Torres Strait Islander infants aged 0 –< 6 months (457.6 per 100,000 per year compared to 133.2 per 100,000 per year in other infants; RR: 3.4; 95% CI: 2.9–4.1) and 6 months –< 1 year (257.2 per 100,000 per year compared to 32.0 per 100,000 per year in other infants; RR: 8.1; 95% CI: 6.1–10.5). Rates were significantly higher for Aboriginal and Torres Strait Islander people than for other people in all age groups except those aged 5–24 years, with the all-age Aboriginal and Torres Strait Islander versus other hospitalisation rate ratio 2.8 (95% CI: 2.5–3.1).

Trends in hospitalisation rates for rotavirus are presented for six states and territories (excluding Tasmania and the Australian Capital Territory) for the 2010–2019 period in Figure 17. Hospitalisation rates among Aboriginal and Torres Strait Islander children in all age groups followed a marked downward trend, reaching their lowest levels in 2019 despite a 2017 peak.

Table 20: Rotavirus hospitalisations, Australia (all jurisdictions), 2016–2019, by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Hospitalisations[a] (2016–2019)			
		n	Rate[b]	Rate ratio	95% CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	438	132.81	4.3	3.8–4.8
	Other	1,603	30.95		
0 –< 6 months	Aboriginal and Torres Strait Islander	153	457.59	3.4	2.9–4.1
	Other	675	133.20		
6 months –< 1 year	Aboriginal and Torres Strait Islander	86	257.21	8.1	6.1–10.5
	Other	162	31.97		
1–4	Aboriginal and Torres Strait Islander	198	75.30	4.1	3.5–4.8
	Other	766	18.39		
5–14	Aboriginal and Torres Strait Islander	26	4.07	1.1	0.7–1.6
	Other	381	3.76		
15–24	Aboriginal and Torres Strait Islander	1-4[c]	0.54	0.5	0.1–1.4
	Other	122	1.14		
25–49	Aboriginal and Torres Strait Islander	NP[c]	2.04	1.8	1.0–2.8
	Other	337	1.15		
50+	Aboriginal and Torres Strait Islander	33	7.16	1.7	1.2–2.4
	Other	1,184	4.19		
All ages[d]	Aboriginal and Torres Strait Islander	518	12.30	2.8	2.5–3.1
	Other	3,627	4.42		

a Hospital admissions where the date of admission was between 1 January 2016 and 30 June 2019. 2019 hospitalisation data was annualised.

b Average annual age-specific rate per 100,000 population.

c To comply with the AIHW's data release condition that hospitalisation counts < 5 be suppressed in published reports, counts between 1 and 4 are reported as a range; other cell counts may be reported as NP (not published) to avoid potential for back calculation of counts < 5.

d Rates for all ages combined are age-standardised to the ABS Australian population estimates for 2016.

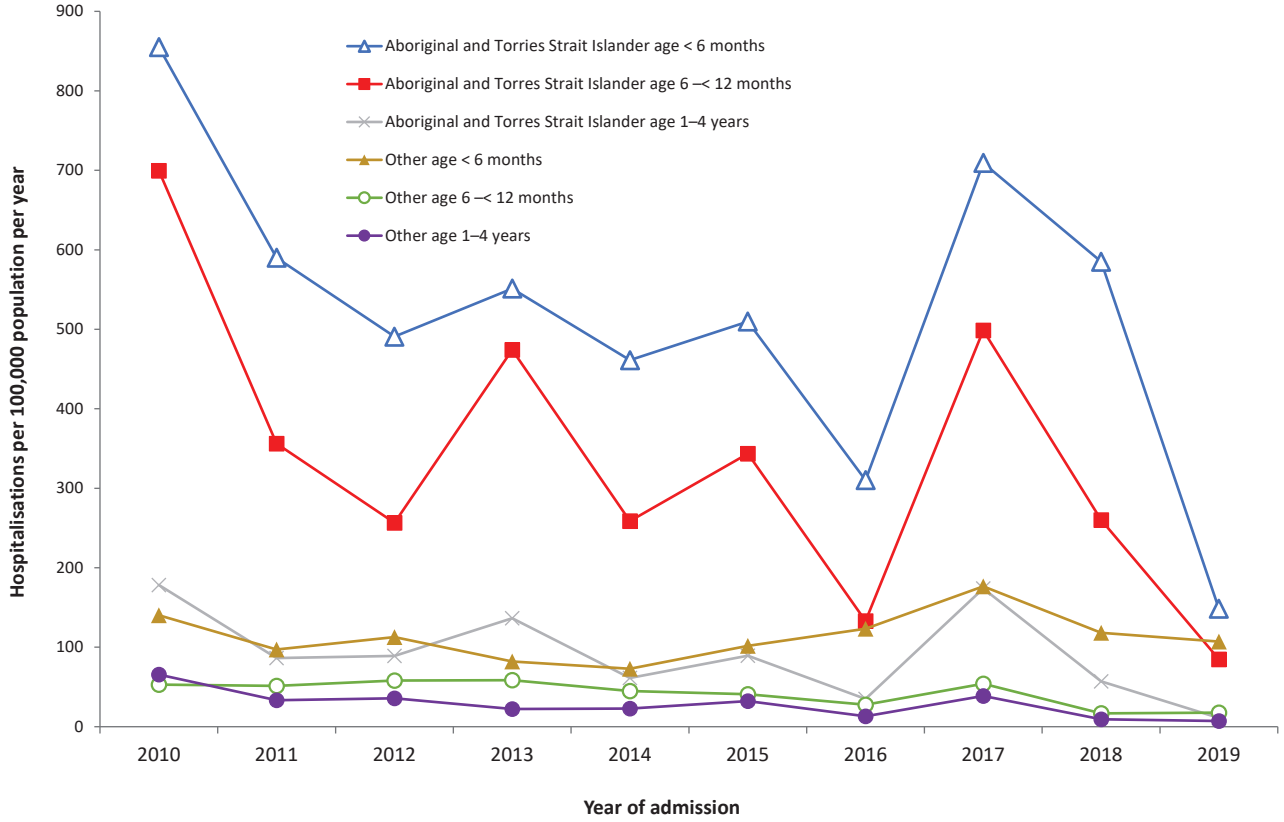
There were a total of seven recorded deaths in Australia for the 2016–2019 period where rotavirus was reported as underlying or associated cause of death, of which 1–5[i] were recorded as being in Aboriginal or Torres Strait Islander people.

Discussion

Rotavirus hospitalisation rates in Aboriginal and Torres Strait Islander infants have decreased by approximately 80% since the introduction of the national rotavirus immunisation program in 2007.[1] However, despite this substantial decline, hospitalisation rates in the 2016–2019 period remained highest in Aboriginal and Torres Strait Islander infants aged 0 –< 6 months (and threefold higher than in other infants) followed by those aged 6 months to < 1 year (eightfold higher than in other infants) and 1–4 years (fourfold higher than in other children). While

i To comply with the Australian Coordinating Registry's data release condition that death rates <6 be suppressed in published reports, counts between 1 and 5 are reported as a range.

Figure 17: Rotavirus hospitalisation rates, Australia (selected jurisdictions),[a] 2010–2019,[b] for selected age groups by Aboriginal and Torres Strait Islander status



a Jurisdictions with satisfactory hospitalisation data quality over the whole time period; refer to Appendix A (Northern Territory, Queensland, New South Wales, Victoria, South Australia and Western Australia).

b Hospital admissions where the date of admission was between 1 January 2010 and 31 December 2019.

rates in older children and adults are much lower, the rates for people in the ≥ 50 years age group may obscure higher rates documented previously in adults aged ≥ 80 years.[198]

The spike in hospitalisation rates seen in our data in 2017, particularly in Aboriginal and Torres Strait Islander infants, reflects multiple outbreaks in several states and territories that year due to rotavirus strains including G2P[4] and equine-like G3P[8] and G8P[8].[199–202] The effectiveness of Rotarix, the vaccine currently used in all states and territories in Australia (a monovalent human G1P[8] vaccine) and RotaTeq, the vaccine used in some states and territories up to 2017 (a pentavalent human-bovine reassortant vaccine with G1, G2, G3, G4 and P[8] genotypes), against specific genotypes remains unclear.

Rotavirus notification data are presented in this report for the first time, after becoming nationally notifiable from 1 July 2018, with data available for the 18-month period from July 2018 to December 2019. Rotavirus notification rates were highest in infants aged 0 –< 6 months, with the rate in Aboriginal and Torres Strait Islander infants 1.6-fold higher than other infants; followed by infants aged 6 months to < 1 year, with the rate in Aboriginal and Torres Strait Islander infants threefold higher than other infants. However, a substantial proportion of notifications in infants aged 0 –< 6 months likely represent vaccine virus shedding,[200] as current assays do not differentiate between wild type rotavirus and vaccine virus,[199,203] with vaccine virus detectable in stool samples up to 4 weeks after rotavirus vaccination.[203,204]

Diarrhoeal disease morbidity among Aboriginal and Torres Strait Islander children follows patterns similar to those seen in less developed, resource-poor settings internationally.[200] Vaccines are less effective in such populations, which are already at higher risk of diarrheal disease.[205] Additionally, social, political, historical and environmental determinants of health have been identified as significant risk factors increasing hospitalisation due to gastroenteritis. These factors include preterm birth, lower socioeconomic status and barriers to accessing early medical intervention.[202,206–208]

The strict upper age cut-offs for rotavirus vaccination have limited the opportunity to improve coverage amongst Aboriginal infants, in whom timeliness of vaccination has been a persisting issue.[209,210] However, the switch from the three-dose RotaTeq to two-dose Rotarix vaccine in 2017 (for those states and territories that had previously been using RotaTeq) has led to an increase in course completion, with rotavirus vaccine coverage in Aboriginal and Torres Strait Islander children increasing from 78.3% in 2016 (versus 87.5% for all children) to 87.3% in 2019 (91.9% for all children; see vaccination coverage chapter). Despite the increased vaccine coverage and decreased hospitalisation rate, ongoing efforts are needed to protect Aboriginal and Torres Strait Islander children, particularly infants, who are still at a disproportionate risk of hospitalisation and severe diarrheal disease. Relaxed upper age limits have been suggested as an option to increase vaccine coverage among Aboriginal and Torres Strait Islander children, although overall risk-benefit profile of this potential change would need to be evaluated before implementing.[211,212] A third dose of Rotarix has been shown to increase the immune response in Aboriginal and Torres Strait Islander children; if this translates into improved protection against disease it could provide an effective strategy.[213] Future strategies also need to take into account the role of the social determinants of health and the political and historical contexts of Aboriginal and Torres Strait Islander children and communities, and risk of novel emerging strains.

13. Varicella-zoster virus infection

Relevant vaccine history

Varicella vaccine

2003
- Varicella vaccine recommended for all children aged 18 months and a catch-up program at 10–13 years without prior history of infection

2005
- Varicella vaccination funded nationally, at 18 months and a catch-up program at 10–13 years of age, for children without prior history of infection

2006
- All jurisdictions commenced school-based catch-up varicella vaccination for one cohort each year of adolescents aged 10–13 years without prior history of infection

2013
- MMRV vaccine recommended and included under the NIP for the single dose of varicella vaccine scheduled at 18 months of age

2017
- Funded adolescent school-based catch-up vaccination program ceased

Relevant vaccine history

Zoster vaccine

2006
- First live zoster vaccine (frozen formulation) registered for use in individuals aged ≥ 60 years (but not marketed in Australia)

2007
- First live zoster vaccine (refrigerated formulation) registered for use in individuals aged ≥ 50 years (limited vaccine availability in 2007–2008)

2009
- A single dose of zoster vaccine recommended for individuals aged ≥ 60 years (no vaccine availability after 2008)

2013
- First live zoster vaccine (refrigerated formulation) available on private prescription

2016
- Single dose of zoster vaccine included under the NIP for people aged 70 years, with a five-year catch-up program for people aged 71–79 years.

2018
- First inactivated recombinant zoster vaccine registered for use in adults aged ≥ 50 years.

The varicella-zoster virus (VZV) causes two distinct diseases: varicella (chickenpox) and herpes zoster (shingles). Varicella is highly contagious and, in children, is generally a benign, self-limiting illness. However, infants, adults and the immunocompromised have significantly higher morbidity and mortality.[214] Complications associated with acute varicella infection include secondary bacterial infection of the skin; pneumonia; encephalitis and other neurological issues; pericarditis; arthritis; and osteomyelitis.[63,215] Varicella infection in pregnancy may result in congenital varicella syndrome in infants, associated with skin scarring, limb defects, and eye or neurological abnormalities.[63] After primary infection, the virus lays dormant in ganglionic neurons in the spinal cord.[214] Herpes zoster is a reactivation of VZV, usually occurring years after the primary infection, when immunity against the virus has waned, or at times of immunocompromise.[216] Herpes zoster causes a painful, localised rash

in a dermatomal distribution.[216] The most common complication of herpes zoster is post-herpetic neuralgia; other potential complications include ophthalmic disease, secondary bacterial infections and scarring, neurological complications and disseminated disease.[63,217]

Results

VZV infection notifications are not presented in this report, as most are unspecified (not designated as either varicella or zoster). Hospitalisation data for varicella are presented for all jurisdictions for the 2016–2019 period in Table 21.

A total of 2,955 hospital admissions for varicella were recorded during this reporting period, of which 107 (3.6%) were recorded as being in Aboriginal and Torres Strait Islander people. Hospitalisation rates in both Aboriginal and Torres Strait Islander and other people were highest in adults aged ≥ 50 years, followed by children aged 0–4 years, with rates similar. Hospitalisation rates were significantly higher in Aboriginal and Torres Strait Islander than other people in the 25–49 year age group (RR: 1.7; 95% CI: 1.1–2.3) and for all ages combined (RR: 1.3; 95% CI: 1.0–1.5).

The trend in varicella hospitalisation rates, for all age groups combined, is presented in Figure 18 for six states and territories (excluding the Australian Capital Territory and Tasmania) for the decade 2010–2019. Rates in Aboriginal and Torres Strait Islander people decreased between 2010 and 2014, then rose to a peak of 6.2 per 100,000 population in 2017 before falling to 2.4 per 100,000 population in 2019. The rate in other Australians was steady from 2010 to 2018, falling to 2.8 per 100,000 population in 2019.

There were 55 deaths recorded in Australia in the 2016–2019 period with varicella as underlying (n = 20) or associated cause of death (n = 35), of which none were recorded as being in Aboriginal and Torres Strait Islander people. Fifty of 55 deaths (90.9%) were in adults aged ≥ 65 years, and no deaths were recorded in children or adolescents.

Table 21: Varicella (chickenpox) hospitalisations, Australia (all states and territories), 2016–2019,[a] by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Hospitalisations (2016 – 2019)[a]			
		n	Rate[b]	Rate ratio	95% CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	19	5.76	1.2	0.7–1.9
	Other	246	4.75		
5–14	Aboriginal and Torres Strait Islander	15	2.35	1.6	0.9–2.8
	Other	147	1.45		
15–24	Aboriginal and Torres Strait Islander	10	1.80	1.2	0.6–2.3
	Other	159	1.49		
25–49	Aboriginal and Torres Strait Islander	36	4.08	1.7	1.1–2.3
	Other	723	2.47		
50+	Aboriginal and Torres Strait Islander	27	5.86	1.1	0.7–1.5
	Other	1,573	5.56		
All ages[c]	Aboriginal and Torres Strait Islander	107	4.27	1.3	1.0–1.5
	Other	2,848	3.38		

a Hospital admissions where the date of admission was between 1 January 2016 and 30 June 2019.

b Average annual age-specific rate per 100,000 population.

c Rates for all ages combined are age-standardised to the Australian Bureau of Statistics Australian population estimates for 2016.

Figure 18: Varicella (chickenpox) hospitalisation rates, Australia (selected states and territories),[a] 2010–2019,[b] by Aboriginal and Torres Strait Islander status.

a States and territories with satisfactory data quality for the 2010–2019 period (refer to Appendix A): Northern Territory, Queensland, New South Wales, Victoria, South Australia and Western Australia.

b Hospital admissions where the date of admission was between 1 January 2010 and 30 June 2019. 2019 hospitalisation data were annualised.

Of 27,781 hospitalisations for herpes zoster recorded during the 2016–2019 period, 521 (1.9%) were recorded as being in Aboriginal and Torres Strait Islander people (Table 22). Hospitalisation rates for herpes zoster generally increased with age, and were highest by far in adults aged ≥ 50 years, with the rate lower in Aboriginal and Torres Strait Islander people than in other people (RR: 0.8; 95% CI: 0.7–0.9). Hospitalisation rates in Aboriginal and Torres Strait Islander were similar to those in other people in children aged 0–4 years and for all age groups combined, but higher in the 5–14 years (RR: 2.2; 95% CI: 1.1–3.9), 15–24 years (RR: 2.0; 95% CI: 1.4–2.8) and 25–49 years (RR: 1.8; 95% CI: 1.5–2.1) age groups (Table 22).

Trends for herpes zoster hospitalisation rates are presented in Figure 19 for six states and territories (excluding the Australian Capital Territory and Tasmania) for the decade 2010–2019. Rates increased in both Aboriginal and Torres Strait Islander and other people from 2010 to 2016 and subsequently decreased in the years from 2017 to 2019.

There were 455 deaths recorded in Australia for the 2016–2019 period with herpes zoster as underlying (n = 143) or associated (n = 312) cause of death, of which 1–5[i] were recorded as being in Aboriginal and Torres Strait Islander people. Of the 455 deaths, 440 (96.7%) were in adults aged ≥ 65 years and 15 (3.3%) in people aged 15–64 years.

i To comply with the Australian Coordinating Registry's data release condition that death counts < 6 be suppressed in published reports, counts between 1 and 5 are reported as a range for this period (2016–2019).

Table 22: Herpes zoster (shingles) hospitalisations, Australia (all states and territories), 2016–2019,[a] by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Hospitalisations (2016–2019) [a]			
		n	Rate[b]	Rate ratio	95% CI for rate ratio
0–4	Aboriginal and Torres Strait Islander	7	2.12	2.4	0.9 – 5.3
	Other	46	0.89		
5–14	Aboriginal and Torres Strait Islander	13	2.03	2.2	1.1 – 3.9
	Other	95	0.94		
15–24	Aboriginal and Torres Strait Islander	40	7.20	2.0	1.4 – 2.8
	Other	378	3.54		
25–49	Aboriginal and Torres Strait Islander	129	14.63	1.8	1.5 – 2.1
	Other	2,412	8.23		
50+	Aboriginal and Torres Strait Islander	332	72.07	0.8	0.7 – 0.9
	Other	24,329	86.00		
All ages[c]	Aboriginal and Torres Strait Islander	521	29.60	1.0	0.9 – 1.0
	Other	27,260	31.07		

a Hospital admissions where the date of admission was between 1 January 2016 and 30 June 2019.

b Average annual age-specific rate per 100,000 population.

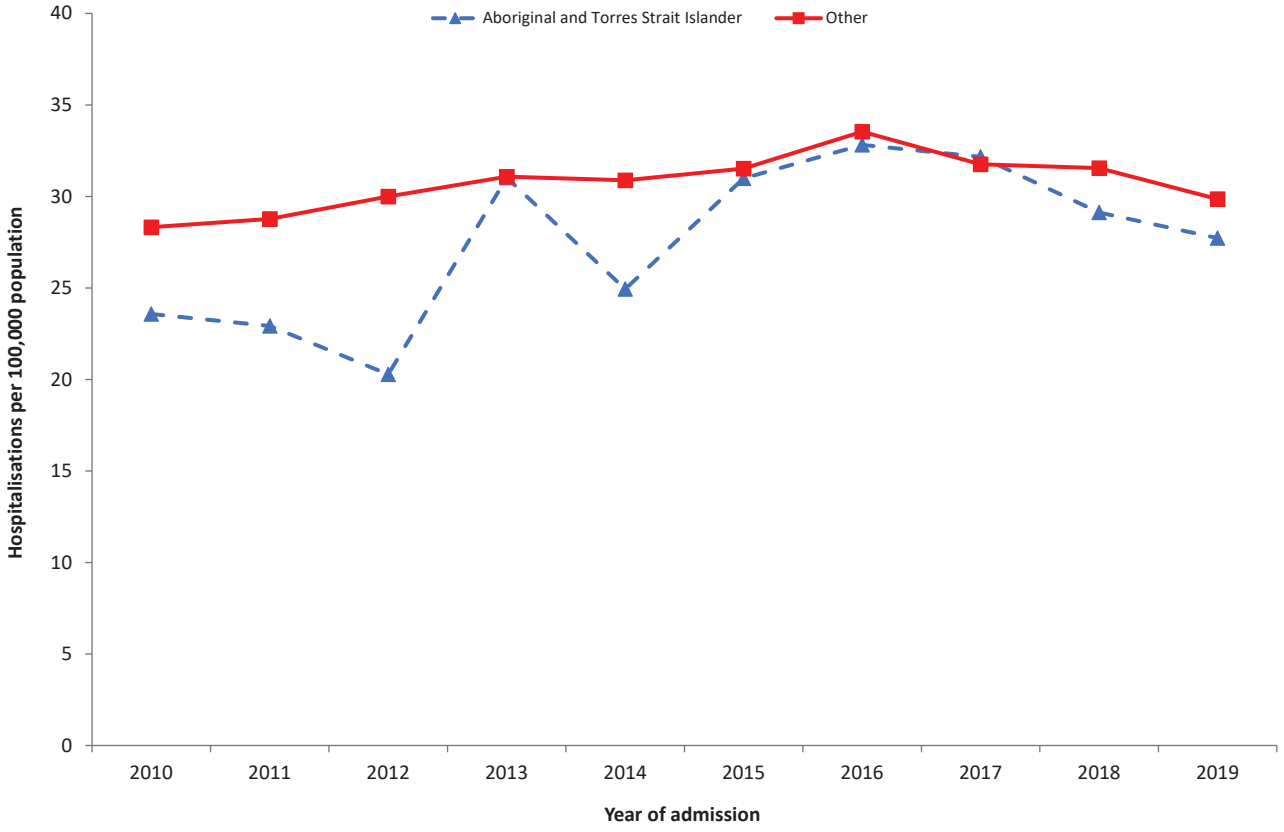
c Rates for all ages combined are age-standardised to the Australian Bureau of Statistics Australian population estimates for 2016.

Discussion

The all-age varicella hospitalisation rate in Aboriginal and Torres Strait Islander people has decreased by 67% since the national varicella immunisation program was introduced in 2005.[3] Age-specific varicella hospitalisation rates were 53% lower in Aboriginal and Torres Strait Islander children aged < 5 years in the 2016–2019 period than in the 2011–2015 period and were 43-44% lower in those aged 5–25 years,[1] suggesting ongoing benefits of the vaccination program. In addition, congenital and neonatal varicella infections have been rare in recent years,[1,218] likely reflecting a combination of direct and indirect (herd protection) effects of vaccination. Previous Australian studies have found that a single dose of varicella vaccine has relatively moderate effectiveness (65–82%) against hospitalisation,[219,220] suggesting that a second dose of vaccine (currently recommended but not funded under the NIP)[1] may be required to realise the full benefit of reductions in hospitalisation rates.

Whilst live attenuated zoster vaccine was recommended for use in 2009, and has been available on private prescriptions since 2013, it was not included on the NIP until 2016. Herpes zoster hospitalisation rates continued to rise until 2016 in both Aboriginal and Torres Strait Islander people and other people, but since then have started to decline. While we found the zoster hospitalisation rate to be lower in Aboriginal and Torres Strait Islander adults aged ≥ 50 years than in other adults, this may

Figure 19: Herpes zoster (shingles) hospitalisation rates, Australia (selected states and territories),[a] 2010–2019,[b] by Aboriginal and Torres Strait Islander status



a States and territories with satisfactory data quality for the 2010–2019 period (refer to Appendix A): Northern Territory, Queensland, New South Wales, Victoria, South Australia and Western Australia.

b Hospital admissions where the date of admission was between 1 January 2010 and 30 June 2019. 2019 hospitalisation data were annualised.

reflect the marked increase in incidence with increasing age within this single broad age group, and lower proportion of Aboriginal and Torres Strait Islander than other people within older age bands.[221] A previous Australian study found that, in the 2007–2011 period, herpes zoster hospitalisation rates among Aboriginal and Torres Islander adults aged ≥ 70 years were similar to other adults, and were twofold higher among Aboriginal and Torres Strait Islander people in adults aged 60–69 years.[222] Likewise, the lower all-age zoster hospitalisation rates in Aboriginal and Torres Strait Islander people in trend data likely reflect the population distribution skewed to younger ages, relative to the overall Australian population, given that the age-standardised rate for the 2016–2019 period was similar.

There were substantially more zoster than varicella hospitalisations in the 2016–2019 period (fivefold more among Aboriginal and Torres Islander people and tenfold among other Australians). As a result, errors in hospital coding, e.g. assigning varicella instead of zoster codes, could have had a differential impact and could have contributed to the finding that varicella hospitalisation rates were highest in adults aged ≥ 50 years.

14. Rare diseases

Four vaccine preventable diseases, now rare in Australia due to successful immunisation programs, are discussed together in this section: diphtheria, tetanus, poliomyelitis and rubella. Notification, hospitalisation and death data are presented for all diseases and states and territories for the 2016–2019 period. Refer to *Summary of National Surveillance Data on Vaccine Preventable Diseases in Australia, 2016–2018* for more detailed information on these diseases.[223]

Diphtheria and tetanus

Relevant vaccine history

No difference in vaccination programs between Aboriginal and Torres Strait Islander and other people

1932
- School-based diphtheria vaccination programs commenced

1975
- First national vaccination schedule recommended and funded four DTPw[i] doses for infants at 3, 4, 5 and 18 months of age; booster doses of tetanus toxoid recommended every 5 years

1978
- 4th dose removed from schedule (reinstated 1985)

1982
- Booster doses of tetanus toxoid recommended every 10 years (changed to dT from 1984)

1994
- Fifth dose added at 4–5 years of age

1999
- DTPa[ii] vaccine recommended and funded for all five childhood DTP doses

2000
- A single dT booster dose recommended at 50 years of age (unless documented within the last 10 years), replacing the recommendation for dT booster doses every 10 years

2003
- 18-month booster replaced by adolescent dose; the eligible age group varied by jurisdiction

2008–2012
- dTpa[iii] vaccine funded temporarily by various jurisdictions for parents/contacts of infants during pertussis epidemic. Program timing and eligibility criteria differed by jurisdiction

2015
- Booster dose of DTPa vaccine recommended at 18 months of age

2016
- Booster dose of DTPa funded at 18 months of age

2017
- Age for which one adult/adolescent formulation dTpa vaccine registered for use lowered from ≥ 10 years to 4 years of age

2018
- dTpa funded under the NIP for all women during the third trimester of pregnancy

i DTPw: Diphtheria-tetanus-pertussis (whole-cell).

ii DTPa: Diphtheria-tetanus-pertussis (acellular).

iii dTpa: Adolescent/adult diphtheria- tetanus-pertussis (acellular).

Diphtheria

Diphtheria is an acute pharyngeal or cutaneous infection caused by toxigenic strains of the bacteria *Corynebacterium diphtheriae, C. ulcerans* and (rarely) *C. pseudotuberculosis*. The major concern with diphtheria infection is fatal acute respiratory obstruction. Diphtheria infection can also occur in skin lesions, particularly in warm climates and under conditions of poor hygiene.[224] The severe symptoms of diphtheria are associated with a toxin produced by the organism. Non-toxigenic forms can cause mild respiratory and skin infections.

There were 34 diphtheria notifications during the 2016–2019 period, with three recorded as being in Aboriginal and Torres Strait Islander people, all in adults aged ≥ 25 years (Table 23).

There were 52 diphtheria hospital admissions during the 2016–2019 period, with six (11.5%) recorded as being in Aboriginal and Torres Strait Islander people (Table 24). The highest age-specific diphtheria hospitalisation rate was in Aboriginal and Torres Strait Islander children aged < 5 years, though based on small numbers (0.6 per 100,000 per year; RR versus other children: 31.4; 95% CI: 1.6-1852.8). Given that there were no diphtheria notifications in children aged < 5 years, the hospitalisations in this age group may represent non-toxigenic cases or coding errors. Only infection with toxigenic diphtheria is notifiable, with notifications regarded as the most reliable source of data, due to routine public health follow-up of laboratory notifications of toxigenic isolates. Between one and five deaths[iv] were recorded in the 2016–2019 period with diphtheria recorded as underlying or associated cause.

Diphtheria has become rare in Australia due to longstanding immunisation programs. However, sporadic cases of serious infection due to toxigenic diphtheria still occur in unvaccinated individuals, and there were three times as many notifications in the 2016–2019 period as in the 2011–2015 period.[1] Cases in the 2016–2019 period were predominantly in adults, reflecting a long-standing epidemiological shift from children to adults, also seen in other developed countries, likely due to a combination of waning post-vaccination immunity and lower historical childhood immunisation coverage.[225] It is important that all individuals remain up-to-date with diphtheria vaccine, particularly travellers as the majority of Australian cases are now acquired overseas.[225]

iv To comply with the Australian Coordinating Registry's data release condition that death counts < 6 be suppressed in published reports, counts between 1 and 5 are reported as a range.

Table 23: Notifications for diphtheria, tetanus, poliomyelitis and rubella, Australia (all states and territories), 2016–2019,[a] by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Diphtheria		Tetanus		Poliomyelitis		Rubella	
		n	Rate[b]	n	Rate[b]	n	Rate[b]	n	Rate[b]
0–4	Aboriginal and Torres Strait Islander	0	0	0	0.00	0	0	1	0.26
	Other	0	0	1	0.02	0	0	3	0.05
5–14	Aboriginal and Torres Strait Islander	0	0	0	0.00	0	0	0	0.00
	Other	2	0.02	2	0.02	0	0	3	0.03
15–24	Aboriginal and Torres Strait Islander	0	0	0	0.00	0	0	0	0.00
	Other	5	0.04	3	0.02	0	0	13	0.11
25–49	Aboriginal and Torres Strait Islander	2	0.20	0	0.00	0	0	0	0.00
	Other	7	0.02	3	0.01	0	0	33	0.10
≥ 50	Aboriginal and Torres Strait Islander	1	0.19	0	0.00	0	0	0	0.00
	Other	17	0.05	8	0.02	0	0	5	0.02
All ages[c]	Aboriginal and Torres Strait Islander	3	0.13	0	0.00	0	0	1	0.03[d]
	Other	31	0.03	17	0.02	0	0	57	0.06

a Notification where date of diagnosis was between 1 January 2016 and 31 December 2019.

b Average annual age-specific rate per 100,000 population.

c Rates for all ages combined are age-standardised in standard population following the Australian Bureau of Statistics 2016 Census.

d Rates not standardised due to low number of Indigenous cases.

Table 24: Hospitalisations for diphtheria, tetanus, poliomyelitis and rubella, Australia (all states and territories), 2016–2019,[a] by age and Aboriginal and Torres Strait Islander status

Age group (years)	Aboriginal and Torres Strait Islander status	Diphtheria[b]		Tetanus[b]		Poliomyelitis[c]		Rubella[b]	
		N	Rate[d]	n	Rate[d]	n	Rate[d]	n	Rate[d]
0–4	Aboriginal and Torres Strait Islander	1–4[e]	0.61	0	0.00	0	0.00	0	0
	Other	1–4[e]	0.02	1–4[e]	0.02	0	0.00	1–4[e]	0.04
5–14	Aboriginal and Torres Strait Islander	0	0.00	1–4[e]	0.16	0	0.00	0	0.00
	Other	1–4[e]	0.03	NP	0.05	1–4[e]	0.01	1–4[e]	0.01
15–24	Aboriginal and Torres Strait Islander	1–4[e]	0.18	0	0.00	0	0.00	1–4[e]	0.18
	Other	5	0.05	16	0.15	0	0.00	5	0.05
25–49	Aboriginal and Torres Strait Islander	1–4[e]	0.34	1–4[e]	0.11	0	0.00	0	0.00
	Other	10	0.03	21	0.07	1–4[e]	0.01	23	0.08
≥ 50	Aboriginal and Torres Strait Islander	0	0.00	0	0.00	0	0.00	0	0.00
	Other	27	0.10	19	0.07	1–4[e]	0.01	25	0.09
All ages[f]	Aboriginal and Torres Strait Islander	6	0.18	1–4[e]	0.06	0	0.00	1–4[e]	0.02
	Other	46	0.05	62	0.07	6	0.007	56	0.07

a Hospital admissions where the date of admission was between 1 January 2016 and 30 June 2019. 2019 hospitalisation data was annualised.

b Principal and associated cause of admission.

c Poliomyelitis as the principal cause of admission only.

d Average annual age-specific rate per 100,000 population.

e To comply with the AIHW's data release condition that hospitalisation counts < 5 be suppressed in published reports, counts between 1 and 4 are reported as a range; other cell counts may be reported as NP (not published) to avoid potential for back calculation of counts < 5.

f Rates for all ages combined are age-standardised in standard population following the Australian Bureau of Statistics 2016 Census.

Tetanus

Tetanus is unique among vaccine preventable diseases in that it is not communicable. It is caused by *Clostridium tetani*, a spore-forming, anaerobic bacterium that grows at the site of injury and produces toxin with local and systemic neuromuscular effects.[226]

There was a total of 17 tetanus notifications in the 2016–2019 period, none of which were recorded as being in Aboriginal and Torres Strait Islander people (Table 23). There were 1–4[v] tetanus hospitalisations recorded as being in Aboriginal and Torres Strait Islander people during the reporting period, and 62 in other Australians (Table 24). There were 1–5 deaths[vi] for which tetanus was recorded as underlying or associated cause between 2016 and 2019, with none reported in Aboriginal or Torres Strait Islander people.

Tetanus is rare in Australia, due to long-standing immunisation programs. However it is likely to be under-notified, as with other diseases relying primarily on clinical notification in the absence of reliable laboratory confirmation.[227] In contrast, hospitalisations may be over-counted due to inter-hospital transfers and coding errors. Maintaining high childhood vaccination coverage and improving coverage in adults would help prevent unnecessary hospitalisations and deaths from tetanus.

v To comply with the AIHW's data release condition that hospitalisation counts < 5 be suppressed in published reports, counts between 1 and 4 are reported as a range.

Poliomyelitis

Poliovirus infection involves the gastrointestinal tract and may progress to the central nervous system. Poliovirus exposure in a susceptible person can lead to asymptomatic infection, minor illness, non-paralytic poliomyelitis (aseptic meningitis) or paralytic poliomyelitis. Post-polio syndrome, which encompasses the late manifestations of acute paralytic polio, occurs in 25–40% of paralytic cases.[228]

Relevant vaccine history

1956
- IPV[vii] programs commenced in individual jurisdictions

1966
- IPV replaced by OPV[viii]

1975
- First national vaccination schedule recommended and funded for infants aged 6, 8 and 10 months

1982
- Fourth dose of OPV vaccine recommended and funded at 5 years of age or prior to school entry

2005
- IPV funded to replace OPV for children in combination vaccine formulations

2011
- Advice provided nationally that first dose of DTPa-hepB-IPV-Hib vaccine could be given as early as 6 weeks of age

There were no notifications (Table 23) and six hospitalisations for acute poliomyelitis (recorded as the principal cause) between 2016 and 2019 (Table 24), with none of the hospitalisations recorded as being in Aboriginal or Torres Strait Islander people. Given the absence of notifications, these hospitalisations likely represents coding error. There were no deaths

vi To comply with the Australian Coordinating Registry's data release condition that death counts < 6 be suppressed in published reports, counts between 1 and 5 are reported as a range.

vii IPV: inactivated poliomyelitis vaccine.

viii OPV: live attenuated oral poliomyelitis vaccine.

reported in Australia in the 2016–2019 period with polio recorded as the underlying cause of death.

Australia was declared polio-free in October 2000. National polio surveillance occurs via several pathways: cases of acute flaccid paralysis in children are notified to the Australian Paediatric Surveillance Unit or the Paediatric Active Enhanced Disease Surveillance System and faecal specimens are referred for virological investigation to the National Enterovirus Reference Laboratory. National enterovirus and environmental surveillance is also undertaken.

Vaccination coverage rates for polio in Australia are high, with 97% of Aboriginal and Torres Strait Islander children and 94% of other children having had dose 4 of a polio-containing vaccine in 2019 (refer to vaccination coverage chapter). However, until polio has been globally eradicated, there is still a (low) risk of reintroduction, particularly in relation to outbreaks in neighbouring countries, such as the vaccine-derived poliovirus type 1 outbreak which occurred in Papua New Guinea in 2018.[229,230]

Rubella

Rubella is caused by the rubella virus. The most common symptoms and signs (rash and lymphadenopathy) are usually transient and benign, and up to 50% of infections are asymptomatic.[231] The severity of the disease increases with age,[232] as does the risk of complications such as thrombocytopenia, encephalitis and a late syndrome of progressive rubella panencephalitis. Rubella is of particular importance when acquired in the first trimester of pregnancy because it is associated with spontaneous abortion or abnormalities of congenital rubella syndrome (CRS) in surviving babies, including cataracts, retinopathy, deafness, heart defects and neurological deficits.[233]

Relevant vaccine history

1971
- Rubella vaccine funded for females aged 12–14 years (school-based program) and for susceptible women prior to pregnancy

1989
- MMR[ix] vaccine recommended and funded on the national schedule at 12 months of age (9 months for Aboriginal and Torres Strait Islander infants in the Northern Territory)

1996
- MMR vaccine funded as second dose of rubella-containing vaccine for all adolescents

1998
- Recommended age for first dose of MMR vaccine for Aboriginal and Torres Strait Islander children in the Northern Territory increased from 9 months to 12 months of age
- Recommended age for second dose of MMR vaccine lowered to 4–5 years

2013
- Second dose moved to 18 months of age, given as MMRV[x]

ix MMR: measles, mumps and rubella.

x MMRV: measles, mumps, rubella and varicella.

There were 58 notifications of rubella, but none of CRS, between 2016 and 2019. Only one rubella notification was recorded as being in an Aboriginal and Torres Strait Islander person (Table 23). There were 1–4[xi] rubella hospitalisations recorded in Aboriginal and Torres Strait Islander people and 19 among other Australians. There were 37 hospitalisations for CRS between 2016 and 2019, all in adults aged 25 years and older, with none recorded as being among Aboriginal and Torres Strait Islander people (Table 24). These CRS hospitalisations are likely to represent admissions in individuals who acquired CRS in utero many years ago when vaccination coverage was lower. There were eight deaths in Australia in the 2016–2019 period with rubella recorded as underlying or associated cause of death (none in Aboriginal and Torres Strait Islander people) and 28 deaths with CRS as underlying or associated cause of death (1–5[xii] deaths among Aboriginal and Torres Strait Islander people). All deaths were in adults aged ≥ 30 years.

No notifications of CRS have been reported to the Australian Paediatric Surveillance Unit (APSU) since 2015,[218] compared to three cases of CRS reported to APSU over the period 2011–2015, all of them in children of overseas-born (Thailand and Indonesia) mothers.[234]

In October 2018, the World Health Organization certified that Australia had eliminated rubella as a public health problem;[235] serosurveillance, vaccine coverage and notification data all attest to this elimination of endemic transmission in Australia.[232,236] Sporadic cases continue to occur, although notified cases may underestimate the true number of cases given the high proportion of asymptomatic or mild cases and the need for laboratory confirmation. The level of laboratory confirmation of hospitalisations is not known. While CRS is now rare, there remains an ongoing burden of hospitalisation and death in adults related to disease acquired congenitally in the past.

xi To comply with the AIHW's data release condition that hospitalisation counts < 5 be suppressed in published reports, counts between 1 and 4 are reported as a range.

xii To comply with the Australian Coordinating Registry data release condition, death counts between 1 and 5 are reported as a range.

15. Vaccination coverage

Key points

By 12 months of age, 92.9% of Aboriginal and Torres Strait Islander children were 'fully vaccinated' in 2019. This is 2.6 percentage point higher than the previous report period and is now only 1.5 percentage points lower than that of other children, a halving of the gap in coverage at 12 months since the previous report.

By 24 months of age, 90.0% of Aboriginal and Torres Strait Islander children were 'fully vaccinated' in 2019 compared with 91.1% of other children. These rates for both groups have increased since the previous report, with the differential reducing to 1.1 percentage points.

By 60 months of age, 96.9% of Aboriginal and Torres Strait Islander children were 'fully vaccinated' in 2019. This is 2.5 percentage point higher than the previous report period and almost 3 percentage points higher than that for other children.

At the sub-jurisdictional level, there was considerable variation in the percentage of Aboriginal and Torres Strait Islander children assessed as 'fully vaccinated' at 12 months of age. While there were a number of SA4s (n = 18) with 'fully vaccinated' coverage below 90%, there were 24 SA4s with coverage in Aboriginal and Torres Strait Islander children higher than the national figure in other children at the same milestone.

Although coverage estimates of vaccines specifically recommended and funded for Aboriginal and Torres Strait Islander children improved, they remained suboptimal.

The percentage of Aboriginal and Torres Strait Islander children vaccinated on time improved between 2016 and 2019, but delayed vaccination remained more common than for other children.

While most delayed vaccinations were given only 1 –≤ 2 months after the schedule point, a higher percentage of Aboriginal and Torres Strait Islander children were vaccinated very late (≥ 7 months after the schedule point).

Adolescent and adult vaccination coverage estimates were reported for the first time in this report.

Vaccination coverage for meningococcal and HPV vaccines among Aboriginal and Torres Strait Islander adolescents was lower than that in other adolescents in 2019.

Influenza vaccination coverage was higher among Aboriginal and Torres Strait Islander people than other Australians in all age groups and increased with age, reaching 83.5% among Aboriginal and Torres Strait Islander adults aged ≥ 75 years, 21.1 percentage points higher than for other adults in 2019.

Zoster vaccine coverage estimates for adults aged 70 years in 2019 were 33.2% among Aboriginal and Torres Strait Islander people, 2.7 percentage points higher than estimates for other people.

The Australian National Immunisation Program

Significant changes to the NIP, immunisation incentives and coverage calculation algorithms between 2016 and 2019 are summarised in Box 1. In addition to the routine vaccines available for all Australians, Aboriginal and Torres Strait Islander children, adolescents and adults are eligible for additional vaccines funded under the NIP. The 2019 NIP schedule is presented in Table 25.

Box 1: Significant changes in immunisation policy, immunisation incentives and coverage calculation algorithms, Australia, 2016–2019[a]

- January 2016 – New immunisation requirements for federal government family assistance payments ('No Jab, No Pay') come into effect. Only parents of children (aged < 20 years, up from < 7 years previously) who are 'fully vaccinated' or on a recognised catch-up schedule are eligible to receive the Child Care Benefit, Child Care Rebate and/or the Family Tax Benefit Part A end-of-year supplement. Children with medical contraindications or natural immunity for certain diseases continue to be exempt from the requirements; however, objection on non-medical grounds is no longer a valid exemption.
- March 2016 – Booster dose of DTPa vaccine funded at 18 months of age.
- November 2016 – National herpes zoster (HZ) vaccination program commenced with a single dose of HZ vaccine funded for all people aged 70 years old, with a five year catch-up program implemented for people aged 71–79 years old.
- December 2016 – Vaccination coverage assessment algorithm for 'fully vaccinated' at the 24-month milestone amended to require four doses of DTPa-containing vaccine.
- July 2017 – Queensland, South Australia, Victoria and Western Australia changed from three-dose RotaTeq® rotavirus vaccine schedule to two-dose Rotarix® schedule (in line with other jurisdictions).
- Coverage for the second dose of MMR-containing vaccine no longer assessed at 60 months of age.

- December 2017 – Funded adolescent school-based Varicella vaccination program ceased.

- February 2018 – A two-dose schedule of 9vHPV vaccine recommended and funded under NIP for female and male adolescents aged 12–14 years, delivered through a school-based program (changed from a three-dose schedule of 4vHPV avaccine in place since 2007 for females and 2013 for males).

- April 2018 – Enhanced trivalent influenza vaccines (high-dose and adjuvanted) funded nationally for all adults aged 65 years and over.

- May 2018 – ACT, NSW, Qld, SA, Tas., Vic.: annual seasonal influenza vaccination program funded for all children aged 6 months to < 5 years (in place in WA since 2008).

- July 2018 – Schedule for routine childhood vaccination with 13vPCV changed from 2, 4 and 6 months of age to 2, 4 and 12 months of age. Vaccination coverage assessment algorithm for 'fully vaccinated' at the 12-month milestone amended to require either two or three doses of 13vPCV. Vaccination coverage assessment algorithm for 'fully vaccinated' at the 24-month milestone amended to require three doses of 13vPCV.

- Meningococcal ACWY conjugate vaccine funded for all children at 12 months of age, replacing combined Hib and MenC-containing, with the Hib dose moved to 18 months and given as monovalent Hib vaccine.

- February 2019 – Aboriginal and Torres Strait Islander children and adolescents aged 5–14 years of age funded for influenza vaccine under NIP (all Aboriginal and Torres Strait Islander people aged 6 months and older now eligible for a funded annual influenza vaccine).

- March 2019 – NT: annual seasonal influenza vaccination program funded for all children aged 6 months to < 5 years.

- April 2019 - Meningococcal ACWY conjugate vaccine funded under the NIP for adolescents aged 14–16 years delivered through a school-based program and adolescents aged 15 to 19 years delivered through primary care providers as part of an ongoing catch-up program.

a Source: NCIRS History of Vaccination.[125]

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Table 25: The Australian National Immunisation Program Schedule in 2019

Age	Vaccine/antigen[a]												
Children													
Birth	Hep B												
2 months	Hep B	DTPa	Hib	Polio					13vPCV		Rotavirus		
4 months	Hep B	DTPa	Hib	Polio					13vPCV		Rotavirus		
6 months	Hep B	DTPa	Hib	Polio					13vPCV[b]				
12 months					MMR		MenACWY	Hep A[c]	13vPCV				
18 months		DTPa	Hib			MMRV		Hep A[c]					
48 months		DTPa		Polio					23vPPV[d]				
6 months – 12 years												Flu[e]	
Adolescents													
13-19 years												Flu[e]	
12 –< 15 years (school programs)[f]		dTpa											HPV
14 –< 16 years (school programs)[f]							MenACWY						
15–19 years										23vPPV[g]			
Adults													
≥ 20 years										23vPPV[g]		Flu[e]	
65 years										23vPPV[h]		Flu[h]	
70–79 years						HZ[i]							
Pregnant women		dTpa[j]										Flu[j]	

a Hep B: hepatitis B; DTPa: diphtheria–tetanus–pertussis (acellular) – paediatric formulation; Hib: Haemophilus influenzae type b; Polio: inactivated polio vaccine; 13vPCV: 13-valent pneumococcal conjugate vaccine; Flu: influenza; MMR: measles-mumps-rubella; Men ACWY: meningococcal ACWY conjugate vaccine; MenB: meningococcal B vaccine; MMRV: measles-mumps-rubella-varicella; dTpa: diphtheria–tetanus–pertussis (acellular) – adolescent/adult formulation; HPV: human papilloma virus; 23vPPV: Pneumovax 23 vaccine; HZ: herpes zoster.

b Aboriginal and Torres Strait Islander children living in Northern Territory, South Australia, Queensland and Western Australia, and children with specified underlying medical conditions that predispose them to invasive pneumococcal disease.

c Aboriginal and Torres Strait Islander children – doses at 12 months and 18 months of age in the Northern Territory, Western Australia, Queensland, and South Australia.

d Medically at-risk children.

e Annual vaccination for Aboriginal and Torres Strait Islander children (aged ≥ 6 months), adolescents and adults and all children ≥ 6 months, adolescents, and adults with medical risk factors.

f Eligible school grades vary between states and territories. MenACWY delivered by health care providers for adolescents aged 16-19 years in a catch up program.

g Aboriginal and Torres Strait Islander adolescents and adults aged 15–49 year with medical risk factors.

h All people 65 years and over.

i All people aged 70 years old, with a five year catch-up program for people aged 71–79 years old until 31 October 2021.

j During the third trimester for dTpa vaccine. At any stage of pregnancy for flu vaccine.

The Australian Immunisation Register

The Australian Childhood Immunisation Register (ACIR) was established on 1 January 1996, incorporating demographic data from Medicare on all enrolled children aged < 7 years.[237] Up until 31 December 2015, no new vaccination records were added after the child had turned 7 years of age. As of 1 January 2016, new vaccination records were added up until the child had turned 20 years of age. From 30 September 2016, the register was expanded further to become the Australian Immunisation Register (AIR), a 'whole-of-life' register, collecting data on vaccinations given at any age in life.[238]

All individuals registered with Medicare are automatically added to AIR. Participation in the AIR is 'opt-out' and so it constitutes a nearly complete population register for Australian residents.[237] Individuals not enrolled in Medicare can also be added to the AIR via a supplementary number.

Since 2001, vaccinations given overseas may be recorded on the immunisation register if a provider endorses their validity. Data are transferred to the AIR when a recognised immunisation provider supplies details of an eligible vaccination. This can occur automatically from medical practice software; through direct data entry on the AIR website; or by submitting paper encounter or history forms. High levels of reporting to AIR for child vaccinations are maintained by a system of incentive payments for immunisation providers and carers, as described elsewhere.[239,240] All vaccination records for an individual remain on the register indefinitely.

Vaccinations recorded on the immunisation register must be given in accordance with the guidelines issued by the Australian Technical Advisory Group on Immunisation (ATAGI).[63] Notifications falling outside these guidelines, or duplicate notifications, prompt an enquiry with the provider and, if their validity cannot be established, they are rejected. The existence of medical contraindications is also recorded on the register. 'Conscientious' objection to vaccination was recorded on the ACIR until 1 January 2016, when the 'No Jab No Pay' policy removed objection to vaccination as a valid exemption to vaccinations linked to family payments; as a result, there was no further need to report objection.[241,242]

This report is the first in the series to present 'whole-of-life' coverage data from the AIR for children, adolescents and adults, following the expansion of the AIR in 2016. For detailed description of methods, refer to Appendix A.

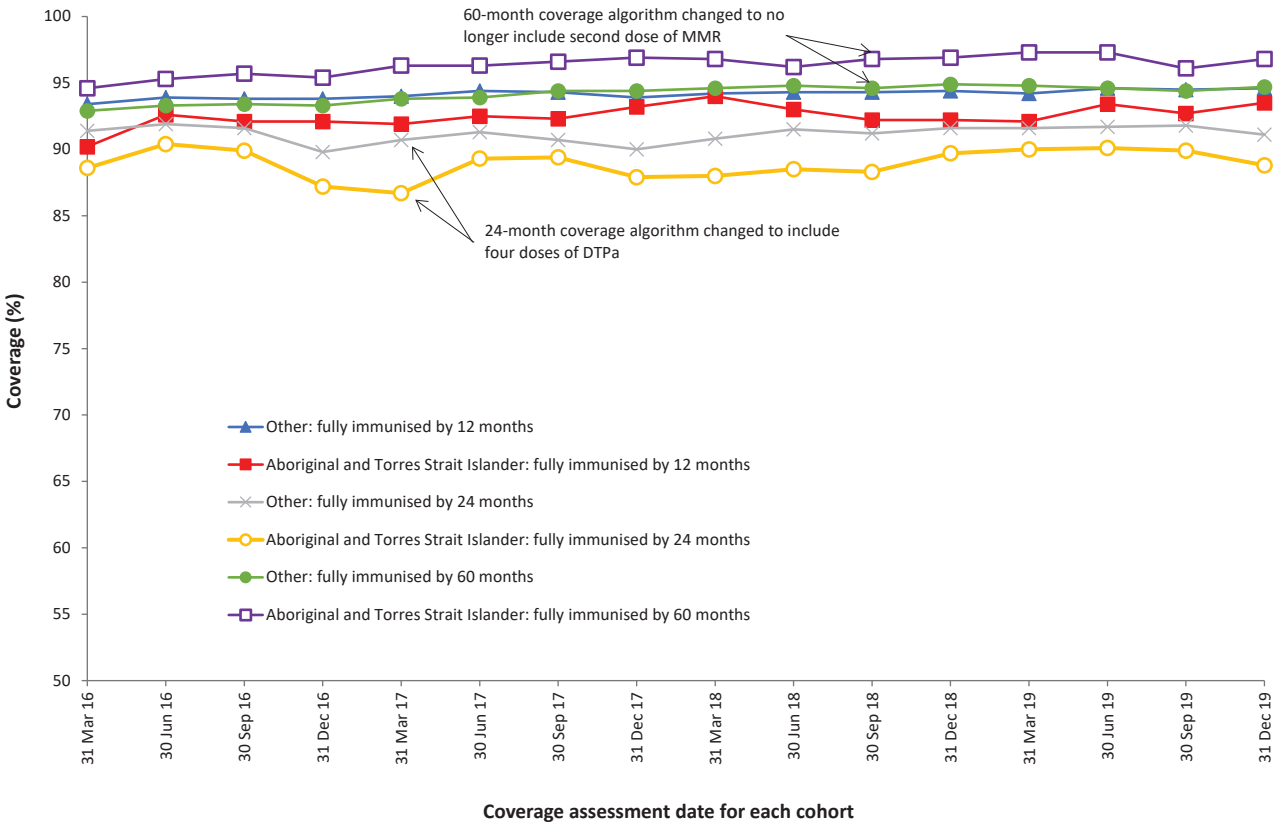
Children

'Fully vaccinated' coverage

Time trends in 'fully vaccinated' coverage for Aboriginal and Torres Strait Islander and other children in Australia, assessed at 12 months, 24 months and 60 months of age between 2016 and 2019, are shown in Figure 20. Between 2016 and 2019, the percentage of children 'fully vaccinated' by 12 months of age was lower for Aboriginal and Torres Strait Islander children than that for other children. However, during the four-year reporting period, 'fully vaccinated' coverage at 12 months of age increased by 3.3 percentage points among Aboriginal and Torres Strait Islander children (compared with a 1.8 percentage point increase for other children), and the coverage differential between Aboriginal and Torres Strait Islander and other children decreased by more than half (Figure 20).

'Fully vaccinated' coverage by 24 months of age decreased for both Aboriginal and Torres Strait Islander and other children between September 2016 and December 2016 following the amendment of the 24 month coverage assessment algorithm for 'fully vaccinated' in December 2016 to include four doses of DTPa-containing vaccine (Figure 20). 'Fully vaccinated' coverage by 24 months of age, then increased steadily for both

Figure 20: Trends in 12-, 24- and 60-month 'fully vaccinated' vaccination coverage estimates[a,b,c] by quarter and Aboriginal and Torres Strait Islander status, Australia, 2016–2019



a By 3-month birth cohorts born between 1 January 2011 and 31 December 2018. Coverage assessment date was 12, 24 or 60 months after the last birth date of each cohort. Vaccination coverage estimates are calculated by quarter and may differ slightly from estimates published elsewhere using rolling annualised data.

b MMR: measles-mumps-rubella; DTPa: diphtheria-tetanus-acellular pertussis.

c Source: Australian Immunisation Register, data as at 31 March 2020.

Aboriginal and Torres Strait Islander children and other children, reaching 88.8% and 91.1%, respectively, in December 2019.

Between 2016 and 2019, the percentage of Aboriginal and Torres Strait Islander and other children 'fully vaccinated' by 60 months of age increased by 2.2 and 1.8 percentage points, respectively, with coverage higher in Aboriginal and Torres Strait Islander children than in other children over the full reporting period (Figure 20). In December 2019, 'fully vaccinated' coverage by 60 months of age among Aboriginal and Torres Strait Islander children was 96.8%, 2.1 percentage points higher than in other children.

Geographic variations of vaccination coverage

Annualised immunisation coverage estimates for 2019 for each of the three milestone ages by Aboriginal and Torres Strait Islander status and jurisdiction are provided in Table 26.

'Fully vaccinated' coverage at 12 months of age in 2019 was 1.5 percentage points lower among Aboriginal and Torres Strait Islander children than other children in Australia, with the differential by jurisdiction varying from 6.0 percentage points lower in Western Australia to 1.5 percentage points higher in the Australian Capital Territory (Table 26).

Table 26: Percentage of children 'fully vaccinated' by 12-, 24- and 60-months of age,[a] by Aboriginal and Torres Strait Islander status and jurisdiction, Australia, 2019

Aboriginal and Torres Strait Islander status	State or territory[b]								
	ACT	NSW	NT	Qld	SA	Tas.	Vic.	WA	Australia
12 months – fully vaccinated[c]									
Aboriginal and Torres Strait Islander	97.5	94.4	92.9	92.7	90.8	95.1	94.4	88.3	92.9
Other	96.0	94.2	93.5	94.0	94.8	94.1	94.7	94.3	94.4
24 months – fully vaccinated[d]									
Aboriginal and Torres Strait Islander	95.0	92.3	89.7	89.9	85.5	93.4	92.6	83.6	90.0
Other	92.8	90.8	90.8	91.5	91.7	90.9	91.9	89.1	91.1
60 months – fully vaccinated[e]									
Aboriginal and Torres Strait Islander	96.6	97.6	97.4	96.6	95.7	97.2	97.5	96.1	96.9
Other	94.9	93.7	92.4	93.6	94.1	94.8	95.2	92.8	94.0

a Source: Australian Immunisation Register, data as at 31 March 2020.

b ACT: Australian Capital Territory; NSW: New South Wales; NT: Northern Territory; Qld: Queensland; SA: South Australia; Tas.: Tasmania; Vic.: Victoria; WA: Western Australia.

c Cohort born 1 January 2018 – 31 December 2018 - 'Fully vaccinated' at 12 months defined as a child having a record on the AIR of 3 doses of a diphtheria-tetanus-pertussis (DTPa)-containing vaccine; 3 doses of a polio vaccine; 2 or 3 doses of a PRP-OMP-containing Haemophilus influenzae type b (Hib) vaccine or 3 doses of any other Hib vaccine; 3 doses of a hepatitis B vaccine; and 2 or 3 doses of a pneumococcal conjugate vaccine.

d Cohort born 1 January 2017 – 31 December 2017. 'Fully vaccinated' – 4 doses of a DTPa-containing vaccine; 3 doses of a polio vaccine; 3 or 4 doses of a PRP-OMP-containing Hib vaccine or 4 doses of any other Hib vaccine; 3 doses of a hepatitis B vaccine; 2 doses of a measles-mumps-rubella (MMR)-containing vaccine; 1 dose of meningococcal C-containing vaccine; 1 dose of varicella vaccine and 3 doses of a pneumococcal conjugate vaccine.

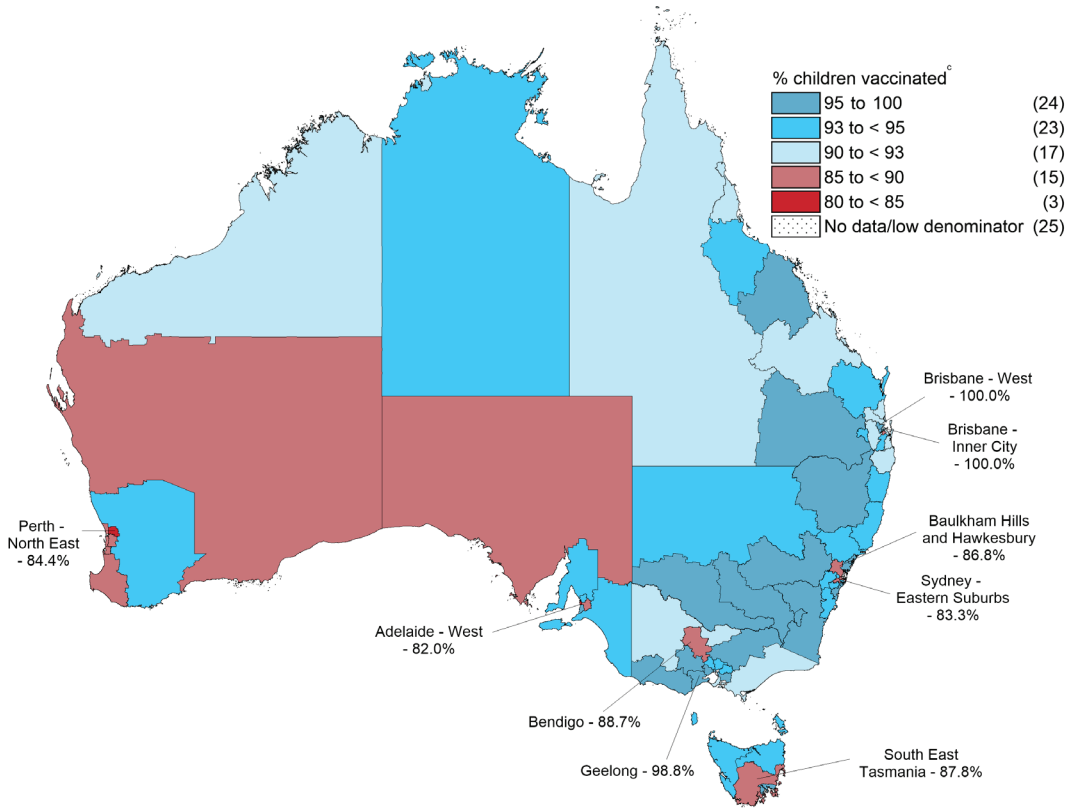
e Cohort born 1 January 2014 – 31 December 2014. 'Fully vaccinated' – 4 or 5 doses of a DTPa-containing vaccine and 4 doses of a polio vaccine.

In 2019, 'fully vaccinated' coverage at 24 months of age among Aboriginal and Torres Strait Islander children was 1.1 percentage points lower than that in other children in Australia, with the differential by jurisdiction varying from 6.2 percentage points lower in South Australia to 2.5 percentage points higher in Tasmania (Table 26).

'Fully vaccinated' coverage at 60 months of age in 2019 was 2.9 percentage points higher among Aboriginal and Torres Strait Islander children than that in other children in Australia and all jurisdictions, with the differential by jurisdiction varying from 1.6 percentage points higher in South Australia to 5.0 percentage points higher in the Northern Territory (Table 26).

'Fully vaccinated' coverage at 12 months of age for Aboriginal and Torres Strait Islander children is presented by SA4 in Figure 21. Throughout each jurisdiction there was considerable variation in the percentage of Aboriginal and Torres Strait Islander children assessed as 'fully vaccinated' at 12 months of age. While there were 18 SA4s with coverage below 90%, there were 24 SA4s with coverage in Aboriginal and Torres Strait Islander children at 12 months

Figure 21: 'Fully vaccinated'[a] coverage at 12 months of age[b] in Aboriginal and Torres Strait Islander children by Statistical Area 4 (SA4),[c] Australia, 2019[d]



a 'Fully vaccinated' at 12 months defined as a child having a record on the AIR of 3 doses of a diphtheria-tetanus-pertussis (DTPa)-containing vaccine; 3 doses of a polio vaccine; 2 or 3 doses of a PRP-OMP-containing *Haemophilus influenzae* type b (Hib) vaccine or 3 doses of any other Hib vaccine; 3 doses of a hepatitis B vaccine; and 2 or 3 doses of a pneumococcal conjugate vaccine.

b Cohort born 1 January 2018 – 31 December 2018.

c Number of SA4s in each category in parentheses.

d Source: Australian Immunisation Register, data as at 31 March 2020.

of age ≥ 95%, higher than the national figure for 'fully vaccinated' in other children at the same milestone (Figure 21).

Individual vaccines

The national 2019 coverage estimates for each individual vaccine assessed at the three milestone ages are provided in Table 27 by Aboriginal and Torres Strait Islander status. Coverage was lower among Aboriginal and Torres Strait Islander children for all vaccines at 12 months of age than among other children, with the exception of the 13-valent pneumococcal conjugate vaccine which was 0.9 percentage points higher. For coverage of individual vaccines assessed at 12 months of age, the difference in the estimates for Aboriginal and Torres Strait Islander and other children was between 1.8% and 2.0%, similar to the difference in 'fully vaccinated' coverage at this milestone (1.5%), except for rotavirus vaccine coverage for which there is an upper age limit. Rotavirus coverage was 4.9 percentage points lower in Aboriginal and Torres Strait Islander children than in other children. At 24 months of age, coverage of the polio, HiB, hepatitis B, MMR (first dose), meningococcal C vaccines and 13-valent pneumococcal conjugate vaccine was higher among Aboriginal and Torres Strait Islander children than in other children. Coverage for all vaccines assessed at the 60

Table 27: Vaccination coverage estimates (%) by age, vaccine and Aboriginal and Torres Strait Islander status, Australia, 2019[a]

Vaccine	Milestone age	Aboriginal and Torres Strait Islander children[b]	Other children[b]
Diphtheria, tetanus, acellular pertussis	12 months[c] (Dose 3)	93.2	95.1
	24 months[d] (Dose 4)	91.5	93.2
	60 months[e] (Dose 4 or 5)	97.4	94.6
Polio	12 months[c] (Dose 3)	93.1	95.1
	24 months[d] (Dose 3)	97.1	96.3
	60 months[e] (Dose 4)	97.0	94.2
Haemophilus influenzae type b	12 months[c] (Dose 3)	93.1	95.0
	24 months[d] (Dose 4)	94.6	94.1
	60 months[e] (Dose 4)	98.9	96.4
Hepatitis B	12 monthsc (Dose 3)	93.1	94.9
	24 months[d] (Dose 3)	97.1	95.8
	60 months[e] (Dose 3)	98.7	96.2
Measles, mumps, rubella	12 months[c]	N/A	N/A
	24 months[d] (Dose 1)	96.6	95.2
	24 months[d] (Dose 2)	92.9	93.5
	60 months[e] (Dose 2)	98.9	96.4
Varicella	12 months[c]	N/A	N/A
	24 months[d] (Dose 1)	92.7	93.7
	60 months[e] (Dose 1)	98.8	96.3
Meningococcal C	12 months[c]	N/A	N/A
	24 months[d] (Dose 1)	96.6	95.1
	60 months[e] (Dose 1)	98.9	96.6
Meningococcal ACWY	12 months[c]	N/A	N/A
	24 months[f] (Dose 1)	95.0	93.6
	60 months[e]	N/A	N/A
13-valent pneumococcal conjugate	12 months[c] (Dose 2 or 3)	97.0	96.1
	24 months[d] (Dose 3)	96.7	95.6
	60 months[e] (Dose 3)	96.9	94.4
Rotavirus	12 months[c] (Dose 2)	87.3	92.2
	24 months[d]	N/A	N/A
	60 months[e]	N/A	N/A

a Source: Australian Immunisation Register, data as at 31 March 2020.

b N/A: Not applicable (vaccine either not given prior to this milestone or contraindicated after previous milestone).

c Cohort born 1 January 2018 – 31 December 2018.

d Cohort born 1 January 2017 – 31 December 2017.

e Cohort born 1 January 2014 – 31 December 2014.

f Cohort born 1 July 2017 – 31 December 2017.

months milestone was higher among Aboriginal and Torres Strait Islander children than among other children at 60 months of age.

Hepatitis A vaccines

Hepatitis A vaccine has been included on the NIP for Aboriginal and Torres Strait Islander children in the Northern Territory, Queensland, South Australia and Western Australia since November 2005, but was used earlier than this in north Queensland. Two doses of hepatitis A vaccine are administered at 12 and 18 months in all jurisdictions. Between September 2016 and March 2017, coverage of two doses of hepatitis A vaccine among Aboriginal and Torres Strait Islander children (assessed at 30 months of age) decreased below the coverage rate at the beginning of the reporting period, to lows of 56.3% in South Australia, 60.9% in Western Australia, and 67.0% in Queensland (Figure 22). However, coverage then increased; and by December 2019, 72.2% of Aboriginal and Torres Strait Islander children in the four jurisdictions had received two doses of hepatitis A vaccine by 30 months of age. Increases in coverage of two doses of hepatitis A vaccine have been achieved for Aboriginal and Torres Strait Islander children in each of the four jurisdictions, although there is a substantial variation: from a low of 64.3% in South Australia to a high of 87.5% in the Northern Territory.

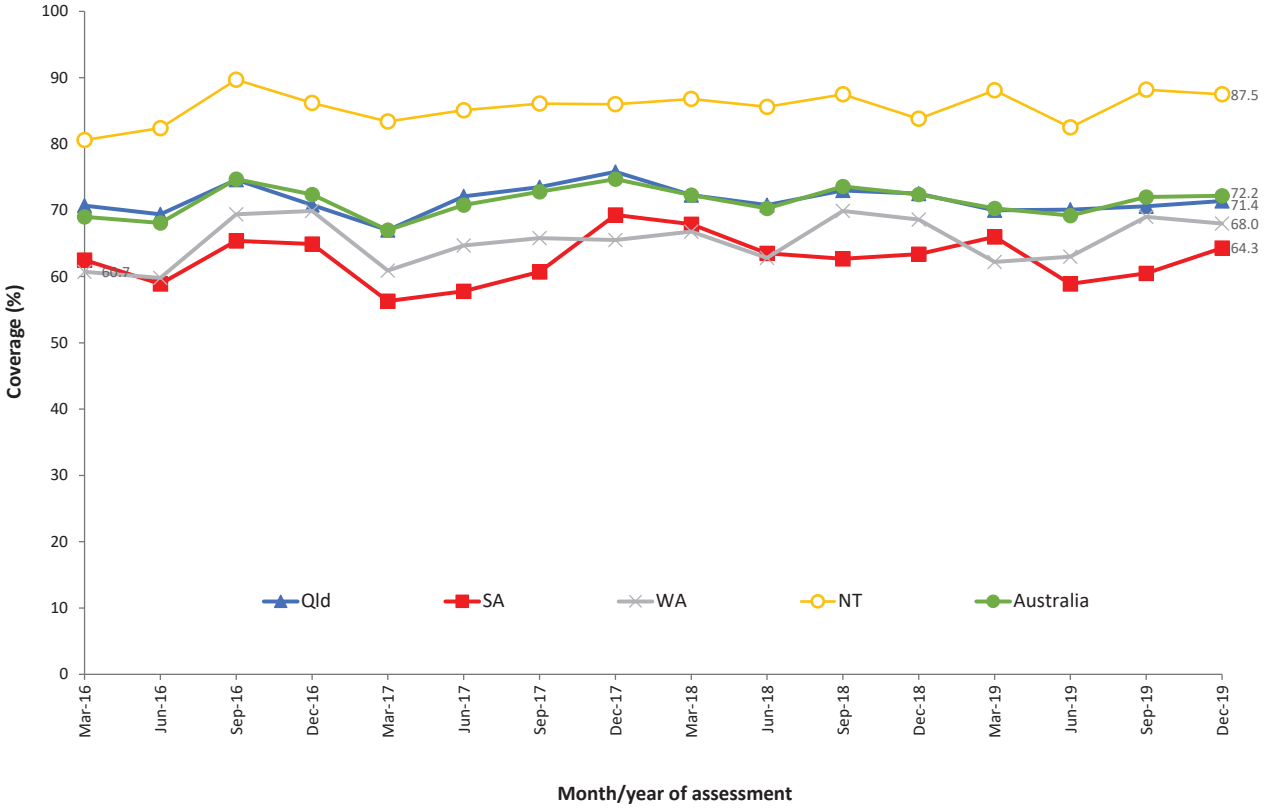
Fourth dose of pneumococcal vaccine

A booster (fourth dose) of pneumococcal vaccine at 18–24 months of age has been recommended and funded for Aboriginal and Torres Strait Islander children in the Northern Territory, Queensland, South Australia and Western Australia since 2001, initially as 23-valent pneumococcal polysaccharide vaccine and then as 13-valent pneumococcal conjugate vaccine (13vPCV) from July 2013 in Queensland, South Australia and Western Australia, and from October 2013 in the Northern Territory. During the reporting period, Aboriginal and Torres Strait Islander coverage estimates of the pneumococcal booster at 18–24 months of age (assessed at 30 months of age) varied substantially between jurisdictions (Figure 23). Coverage increased steadily in the Northern Territory from 84.4% in March 2016 to 92.6% in December 2019, and more rapidly in South Australia from 59.7% in March 2016 to 74.1% in December 2019. Coverage rates in Western Australia decreased across the reporting period to a low of 53% in June 2019, increasing again in the last two quarters of 2019 to reach 60.7% at the end of the reporting period. In Queensland, coverage decreased from 69.5% in March 2016 to a low of 45.7% in September 2019, then increased to 53.1% at the end of 2019.

Seasonal influenza vaccine

In 2015, seasonal influenza vaccine was recommended and funded on the NIP for all Aboriginal and Torres Strait Islander children aged 6 months to < 5 years. Prior to this, national recorded coverage of the seasonal influenza vaccine was below 4% for Aboriginal and Torres Strait Islander children. In 2016, recorded coverage of the seasonal influenza vaccine was 11.6% for Aboriginal and Torres Strait Islander children, more than four times the coverage in other Australian children (Figure 24). Coverage in Aboriginal and Torres Strait Islander children increased across the reporting period, reaching 14.9% in 2017, 31.4% in 2018 and 43.6% in 2019. In May 2018, an annual seasonal vaccination program for all children 6 months to 5 years was funded in six jurisdictions (Australian Capital Territory, New South Wales, Queensland, South Australia, Tasmania and Victoria; the program was in place in Western Australia since 2008). The program resulted in an increase in influenza coverage in other Australian children; by 2019, it was two percentage points lower in other children than coverage in Aboriginal and Torres Strait Islander children. However, unlike most other routine childhood vaccines on the NIP, influenza vaccine notifications do not attract notification payments for immunisation providers. As such, influenza vaccine coverage data should be regarded as a minimum estimate due to the potential for under-reporting.

Figure 22: Trends in coverage estimates[a] for hepatitis A vaccine[b] for Aboriginal and Torres Strait Islander children by quarter of vaccination and jurisdiction, Australia,[c,d] 2016–2019



a Vaccination coverage estimates calculated using 3-month wide birth cohorts by quarter.

b 18-month dose assessed at 30 months of age in all four jurisdictions.

c Northern Territory (NT), Queensland (Qld), South Australia (SA) and Western Australia (WA) only.

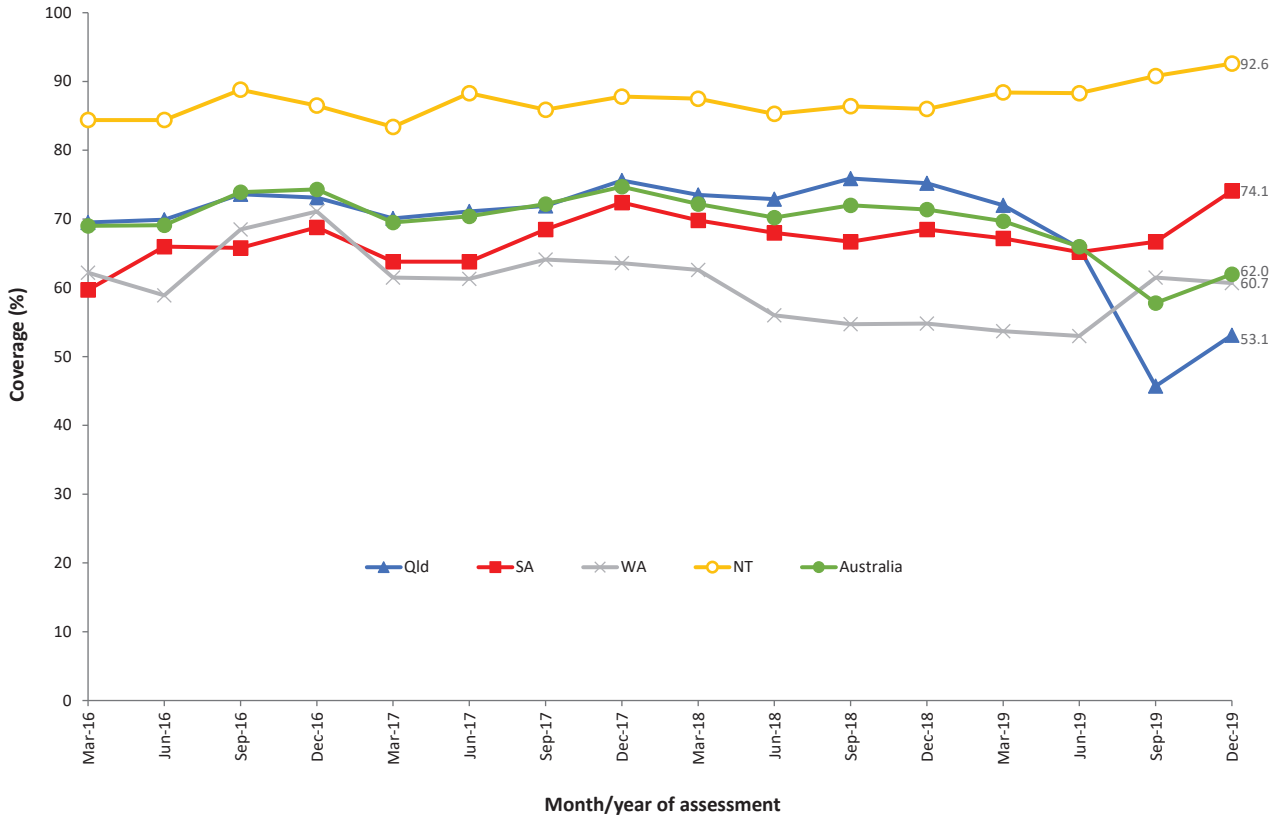
d Source: Australian Immunisation Register, data as at 31 March 2020.

Timeliness of vaccination

The percentage of children with delayed receipt of the second dose of pneumococcal vaccine, due at 4 months of age, by Aboriginal and Torres Strait Islander status in the 2016–2019 reporting period is shown in Figure 25. The percentage of Aboriginal and Torres Strait Islander children with any delay was higher, throughout the reporting period (19.0% in 2019), than was the percentage for other children (8.4% in 2019), but decreased by 3.3 percentage points for Aboriginal and Torres Strait Islander children from 2016 to 2019. Most of the delay was relatively short (1 –≤ 2 months after the schedule point) for both Aboriginal and Torres Strait Islander and other children. Only a small percentage of other children received the vaccine very late, at ≥ 7 months after the schedule point, ranging between 0.6% and 0.8% during the reporting period. In comparison, the percentage of Aboriginal and Torres Strait Islander children with very late receipt of the second dose of pneumococcal vaccine was higher, although this percentage decreased from 3.1% in 2016 to 1.8% in 2019.

The percentage of children with delayed receipt of the second dose of DTPa vaccine, due at 4 months of age, by Aboriginal and Torres Strait Islander status in the 2016–2019 reporting period is shown in Figure 26. The percentage of Aboriginal and Torres Strait Islander children with any delay was higher, throughout the reporting period (19.1% in 2019), than was the percentage for other children (8.2% in 2019), but decreased 3.4 percentage points for Aboriginal and Torres Strait Islander children

Figure 23: Trends in coverage estimates[a] for the fourth dose of pneumococcal vaccine[b] for Aboriginal and Torres Strait Islander children by quarter of vaccination and jurisdiction, Australia,[c,d] 2016–2019



a Vaccination coverage estimates calculated using 3-month wide birth cohorts by quarter.

b 12-month booster dose assessed at 30 months of age in all four jurisdictions.

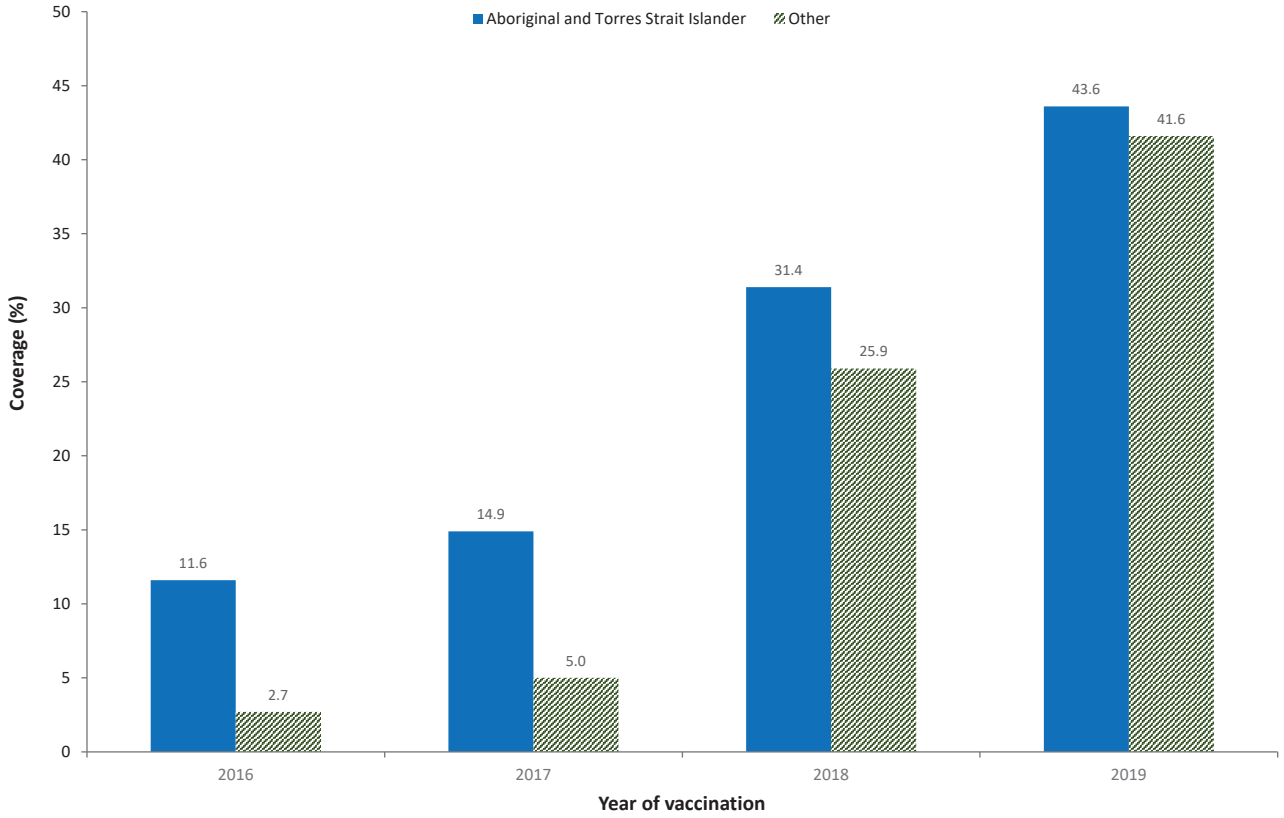
c Northern Territory (NT), Queensland (Qld), South Australia (SA) and Western Australia (WA) only.

d Source: Australian Immunisation Register, data as at 31 March 2020.

from 2016 to 2019 (Figure 26). Most of the delay was relatively short (1 –≤ 2 months after the schedule point) for both Aboriginal and Torres Strait Islander and other children. Only a small percentage of other children received the vaccine very late, at ≥ 7 months after the schedule point, ranging between 0.7% and 1.0% during the reporting period. In comparison, the percentage of Aboriginal and Torres Strait Islander children with very late receipt of the second dose of DTPa vaccine was higher, although this percentage decreased from 3.2% in 2016 to 2.0% in 2019.

Delayed receipt of the third dose of pneumococcal conjugate vaccine for Aboriginal and Torres Strait Islander children, by jurisdiction, for 2019 is shown in Figure 27. The percentage of Aboriginal and Torres Strait Islander children vaccinated late, more than one month after the scheduled time point at 6 months old, was higher than that for the second dose of the pneumococcal vaccine and varied between jurisdictions, with the highest percentages of delayed receipt seen in Western Australia (47.7%), South Australia (40.6%), Northern Territory (37.1%) and Queensland (36.0%). Most of the delay in receipt of the third dose of pneumococcal conjugate vaccine in all jurisdictions was short (1 –< 3 months after the schedule point), although 7.6% of Aboriginal and Torres Strait Islander children in Western Australia received their

Figure 24: Trends in recorded coverage of seasonal influenza vaccine[a,b] for children aged 6 months to < 5 years, Australia, 2016–2019 by Aboriginal and Torres Strait Islander status



a Any influenza vaccine dose.

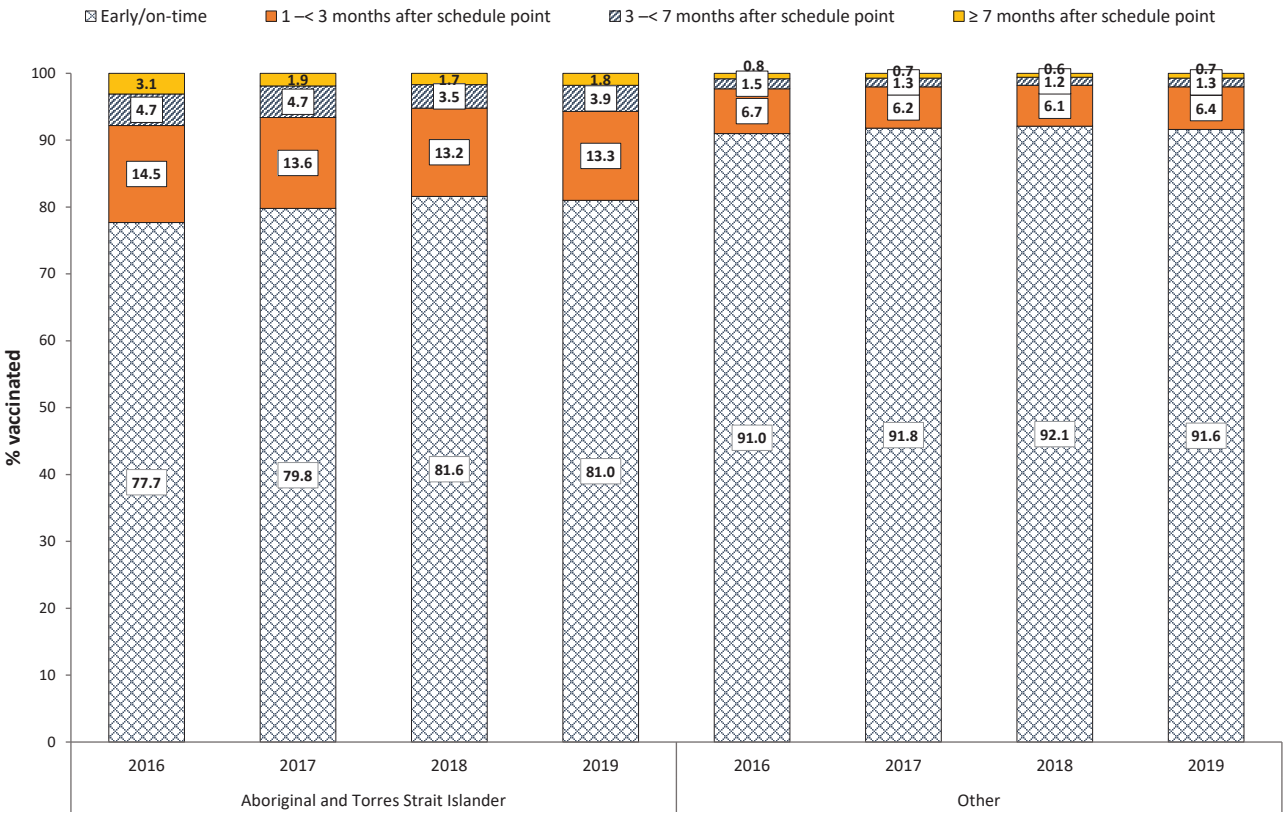
b Source: Australian Immunisation Register, data as at 31 March 2021.

third dose of pneumococcal conjugate vaccine ≥ 7 months after the scheduled time point at 6 months of age.

Figure 28 shows the percentage of children with delayed receipt of the first dose of MMR vaccine, due at 12 months of age, by Aboriginal and Torres Strait Islander status in the 2016–2019 reporting period. The percentage of Aboriginal and Torres Strait Islander children vaccinated on-time by 13 months of age did not vary substantially over the reporting period and was 66.0% in 2019, 11.1 percentage points below other children. Only a small percentage of other children received the first dose of the MMR vaccine very late, at ≥ 7 months after schedule points, ranging between 1.1% and 1.3% during the reporting period. In comparison, the percentage of Aboriginal and Torres Strait Islander children with very late receipt of the first dose of MMR vaccine was higher in each year of the reporting period, although it declined from 2.9% in 2016 to 2.3% in 2019. Most of the delay in receipt of the first dose of MMR was relatively short (1 –< 3 months after the schedule point) for both Aboriginal and Torres Strait Islander children and other children.

To capture an additional aspect of vaccination timeliness, 'fully vaccinated' coverage estimates assessed three months after the last vaccine dose due (earlier than the standard assessment milestones) are presented by remoteness in Table 28, along with coverage estimates for the standard 12-month, 24-month and 60-month age milestones. 'Fully vaccinated' coverage in 2019 at the four earlier milestones (9-month, 15-month, 21-month and 51-month) was lower in Aboriginal and Torres Strait Islander children residing in remote and very remote

Figure 25: Trends in timeliness[a] of the second dose of pneumococcal vaccine by Aboriginal and Torres Strait Islander status, Australia, 2016–2019[b,c]



a Based on the number of children who received vaccine dose at particular ages divided by the total number of children who received the vaccine dose, expressed as a percentage.

b Cohort born in 2014 for 2016 timeliness assessment; born in 2015 for 2017 timeliness assessment; born in 2016 for 2018 timeliness assessment; and born in 2017 for 2019 timeliness assessment.

c Source: Australian Immunisation Register, data as at 31 March 2020.

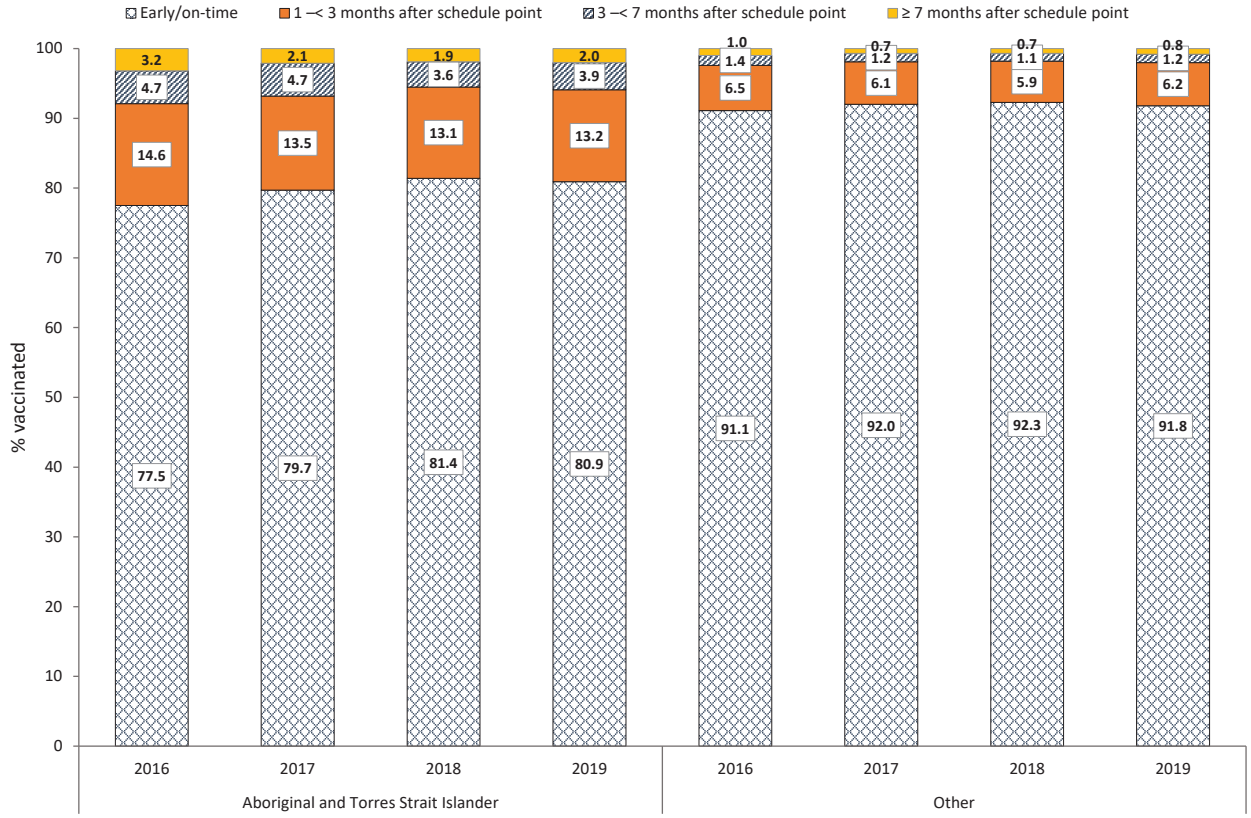
areas than in those residing in regional areas and major cities, with the greatest difference at 21 months of age (6.8 percentage points lower than regional areas and 6.5 percentage points lower than major cities) (Table 28). The smallest differentials for Aboriginal and Torres Strait Islander children residing in remote areas was at the 51-month milestone, for which those in remote areas were 1.5 percentage points lower than those in regional areas and 0.4 of a percentage point lower than those in major cities. Compared to major cities and regional areas, 'fully vaccinated' coverage for other children in remote areas was 2.0–2.9 percentage points lower at 21 months and 1.7–2.6 percentage points lower at 51 months of age (Table 28). 'Fully vaccinated' coverage in 2019 was higher at the standard milestones than at the earlier milestones, for both Aboriginal and Torres Strait Islander and other children and across all remoteness categories, most pronounced for vaccines due at 48 months when assessed at 51 months instead of at 60 months.

Adolescents

HPV

HPV vaccination coverage by Aboriginal and Torres Strait Islander status, gender and age cohort, based on age at 31 December 2019, is shown in Table 29. Coverage among adolescent girls is several percentage points higher than in adolescent boys, for all birth cohorts and both Aboriginal and Torres Strait Islander and other adolescents. Dose 1 HPV vaccination coverage

Figure 26: Trends in timeliness[a] of the second dose of DTPa vaccine by Aboriginal and Torres Strait Islander status, Australia, 2016–2019[b,c]



a Based on the number of children who received vaccine dose at particular ages divided by the total number of children who received the vaccine dose, expressed as a percentage.

b Cohort born in 2014 for 2016 timeliness assessment; born in 2015 for 2017 timeliness assessment; born in 2016 for 2018 timeliness assessment; and born in 2017 for 2019 timeliness assessment.

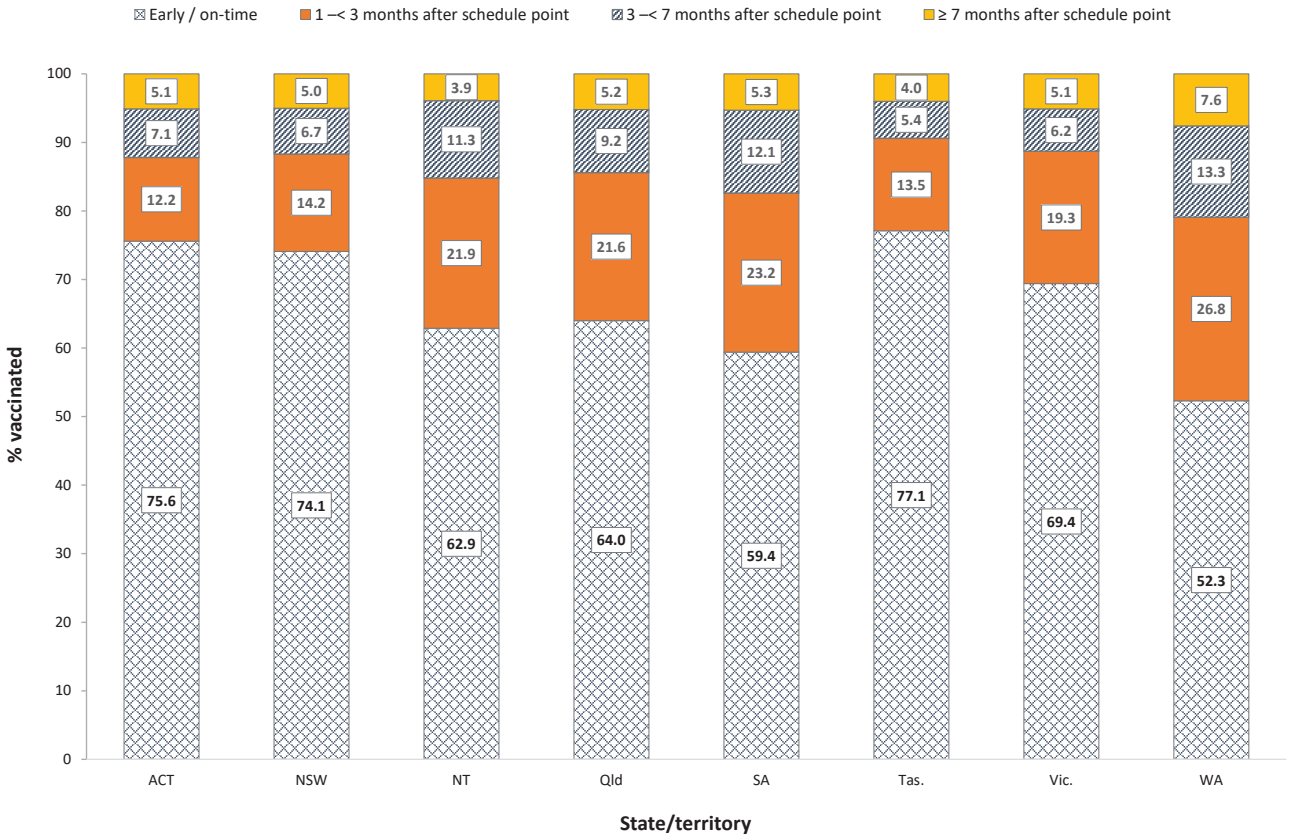
c Source: Australian Immunisation Register, data as at 31 March 2020.

is comparable for Aboriginal and Torres Strait Islander and other adolescents, except for 13, 14 and 19 year old Aboriginal and Torres Strait Islander boys who have dose 1 HPV coverage 3.8–5.4 percentage points lower than other adolescents (Table 29). Completion of the HPV vaccination schedule (i.e. receipt of three doses prior to 2018 and receipt of two doses from 2018) is lower in Aboriginal and Torres Strait Islander adolescents than in other adolescents. This disparity was greatest among adolescent boys, with the percentage point difference over 10 points lower in all cohorts except those aged 15 years (8.5 percentage points) (Table 29). For adolescent girls, the disparity was smaller, ranging from 4.9 percentage points lower in the 15 year olds to 8.7 percentage points lower in the 19 year olds.

Meningococcal ACWY vaccine

The percentage of adolescents in Australia who received a meningococcal ACWY dose by 31 December 2019, by age, Aboriginal and Torres Strait Islander and jurisdiction, is shown in Table 30. Adolescents aged 16 years (cohort born in 2003) were the first cohort to be eligible for a funded meningococcal ACWY vaccination under the NIP, implemented in April 2019. In this cohort, the coverage in Aboriginal and Torres Strait Islander adolescents was 66.1%, 6 percentage points lower than in other adolescents. Coverage among Aboriginal and Torres Strait Islander adolescents ranged from 46.6% in South Australia to 78.5% in Tasmania, and was lower than in other adolescents in every jurisdiction except Tasmania (78.5% vs 76.5%)

Figure 27: Timeliness[a,b,c] of the third dose of pneumococcal conjugate vaccine for Aboriginal and Torres Strait Islander children by jurisdiction, Australia, 2019



a Based on the number of children who received vaccine dose at particular ages divided by the total number of children who received the vaccine dose, expressed as a percentage.

b Cohort born in 2017.

c Source: Australian Immunisation Register, data as at 31 March 2020.

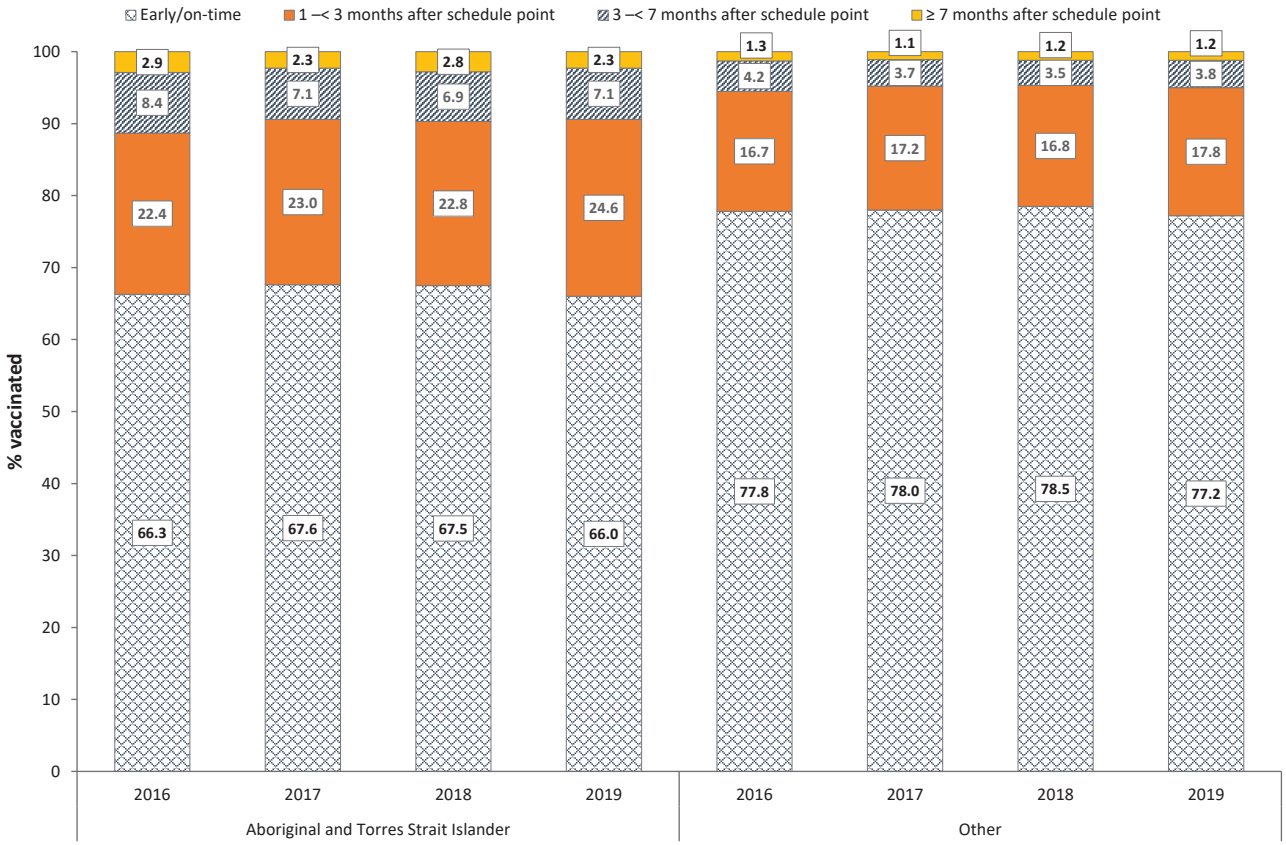
and the Northern Territory (77.1% vs 68.2%) (Table 30). Prior to the funding of meningococcal ACWY vaccination under the NIP, adolescents received the meningococcal ACWY vaccine as part of jurisdictional funded programs that were in place for varying times and for various eligible risk groups or age cohorts. For adolescents aged 17 years (cohort born in 2002) and receiving the vaccine through the state/territory funded programs, national coverage of the meningococcal ACWY vaccine was 64.1% among Aboriginal and Torres Strait Islander adolescents and 69.5% among other adolescents (Table 30). Coverage in this age group varied by jurisdiction, with the lowest coverage in South Australia for both Aboriginal and Torres Strait Islander (24.4%) and other (16.4%) adolescents. Higher coverage of meningococcal ACWY vaccine among Aboriginal and Torres Strait Islander 17 year olds was observed in Tasmania (78.0%) and the Northern Territory (78.4%) where the coverage was higher than that in other adolescents in those jurisdictions.

Adults

Zoster

Nationally, recorded zoster vaccine coverage for adults aged 70 years in 2019 was 33.2% among Aboriginal and Torres Strait Islander people and 30.5% in other people (Figure 29). Zoster coverage in Aboriginal and Torres Strait Islander adults ranged from 7.1% in the Australian Capital Territory to 46.4% in Tasmania and was higher among Aboriginal and Torres Strait Islander people than in other people in New South Wales, Victoria, Tasmania, and the Northern Territory.

Figure 28: Trends in timeliness[a] of the first dose of measles, mumps, rubella vaccine by Aboriginal and Torres Strait Islander status, Australia, 2016–2019[b,c]



a Based on the number of children who received vaccine dose at particular ages divided by the total number of children who received the vaccine dose, expressed as a percentage.

b Cohort born in 2014 for 2016 timeliness assessment; born in 2015 for 2017 timeliness assessment; born in 2016 for 2018 timeliness assessment; and born in 2017 for 2019 timeliness assessment.

c Source: Australian Immunisation Register, data as at 31 March 2020.

Influenza vaccination – children, adolescents and adults

National vaccination uptake of at least one dose of influenza vaccine recorded on AIR in 2019 is presented by age group for Aboriginal and Torres Strait Islander people and other Australians in Figure 30. Influenza vaccination uptake among Aboriginal and Torres Strait Islander people was higher than that for other Australians for each age group. In the 10 –< 15 years age group, influenza uptake was 29.4% among Aboriginal and Torres Strait Islander people, 11.4 percentage points higher than that of other Australians. The uptake of influenza vaccination among Aboriginal and Torres Strait Islander people was 31.1% in the 20 –< 50 age group, 16.3 percentage points higher than that in other Australians. Similarly, influenza vaccination uptake was more than double in Aboriginal and Torres Strait Islander people than in other Australians in the 50 –< 65 year age group (52.7% vs 24.3%). The highest uptake was among those aged ≥ 75 years for both Aboriginal and Torres Strait Islander people and other Australians, with a differential of 21.1 percentage points (83.5% vs 62.4%).

Discussion

In Australia, Aboriginal and Torres Strait Islander coverage estimates for 'fully vaccinated' coverage at 12, 24 and 60 months of age improved between 2016 and 2019, although coverage was lower each year than that of other children at 12 and 24 months of age.

Table 28: 'Fully vaccinated' coverage estimates assessed at earlier (9, 15, 21, 51) compared to standard (12, 24, 60 months of age: shaded) milestones,[a] by Aboriginal and Torres Strait Islander status and remoteness of area of residence,[b] Australia, 2019[c]

Indigenous status	Remoteness category[b]	9 months (%)[d]	12 months (%)[d]	15 months (%)[e]	21 months (%)[e]	24 months (%)[e]	51 months (%)[f]	60 months (%)[f]
Indigenous	Major cities	86.5	92.8	85.6	82.6	89.8	83.4	96.6
	Inner and outer regional	86.1	93.3	86.2	82.9	90.7	84.5	97.1
	Remote and very remote	81.7	91.9	84.1	76.1	88.0	83.0	97.3
	All	**85.6**	**92.9**	**85.6**	**81.8**	**90.0**	**83.8**	**96.9**
Other	Major cities	91.6	94.4	88.2	86.6	90.9	85.0	93.9
	Inner and outer regional	91.4	94.3	89.4	87.5	92.1	85.9	94.5
	Remote and very remote	91.9	95.0	88.7	84.6	91.1	83.3	93.5
	All	**91.5**	**94.4**	**88.5**	**86.8**	**91.1**	**85.2**	**94.0**

a Coverage algorithm used for 9/21/51 month milestones same as for 12/24/60, respectively; algorithm used for 15 months same as that for 24 months but excludes doses due at 18 months.

b Accessibility/Remoteness Index of Australia (ARIA++).

c Source: Australian Immunisation Register, data as at 31 March 2020.

d Cohort born 1 January 2018 – 31 December 2018.

e Cohort born 1 January 2017 – 31 December 2017.

f Cohort born 1 January 2014 – 31 December 2014.

The percentage of Aboriginal and Torres Strait Islander children assessed as 'fully vaccinated' by 12 months of age increased by 3.3 percentage points over the four-year period, leading to a halving of the coverage differential between Aboriginal and Torres Strait Islander children and other children. 'Fully vaccinated' coverage estimated at 24 months of age decreased in late 2016 following the change in coverage algorithm to include 4 doses of DTPa-containing vaccine, but increased from March 2017 to reach 88.8% in Aboriginal and Torres Strait Islander children at the end of 2019, 0.2 percentage points above the coverage rate at the beginning of the reporting period. Coverage assessed at 24 months of age is lower than that at 12 and 60 months, mainly due to the larger number of vaccines/antigens required to be 'fully vaccinated' at 24 months.

'Fully vaccinated' coverage by 60 months of age among Aboriginal and Torres Strait Islander children improved by 2.2 percentage points over the four-year period and was also 2.1 percentage points higher than coverage in other children by the end of 2019. The coverage estimates for Aboriginal and Torres Strait Islander children at 12, 24 and 60 months in 2019 varied substantially between states and territories and between SA4s.

Coverage for hepatitis A vaccine and the fourth dose of 13vPCV, which are funded under the NIP for Aboriginal and Torres Strait Islander children in four jurisdictions only (South Australia, Northern Territory, Queensland and Western Australia), remained suboptimal in 2019, at 72.2% and 62.0%, respectively, although coverage in the Northern Territory continued to be substantially higher than in the other three jurisdictions. Coverage of the fourth dose of 13vPCV vaccine only increased between 2016 and 2019 in South Australia (68.8% to 74.1%) and the Northern Territory (86.5% to 92.6%). Recorded national influenza vaccination uptake in Aboriginal and Torres Strait Islander children

Table 29: Cumulative coverage (%) for HPV vaccine by first and final dose number,[a] gender, Aboriginal and Torres Strait Islander status and age/birth cohort[b] for vaccination encounters recorded up to 31 December 2019[c]

Aboriginal and Torres Strait Islander status	Age at 31 Dec 2019 (birth cohort)													
	13 years[d] (1 Jan – 31 Dec 2006)		14 years (1 Jan – 31 Dec 2005)		15 years[e] (1 Jan – 31 Dec 2004)		16 years (1 Jan – 31 Dec 2003)		17 years (1 Jan – 31 Dec 2002)		18 years (1 Jan – 31 Dec 2001)		19 years (1 Jan – 31 Dec 2000)	
	Dose 1	Dose 2	Dose 1	Dose 2	Dose 1	Dose 2	Dose 1	Dose 3	Dose 1	Dose 3	Dose 1	Dose 3	Dose 1	Dose 3
Girls														
Aboriginal and Torres Strait Islander	77.2	61.8	85.3	72.5	87.8	77.9	88.8	70.5	87.4	70.4	85.5	69.1	82.4	66.7
Other	78.5	70.9	85.5	80.0	96.2	82.8	86.1	78.3	86.1	78.5	85.0	77.5	82.7	75.4
Boys														
Aboriginal and Torres Strait Islander	70.0	53.0	79.8	65.9	83.0	71.8	83.7	63.2	82.7	64.5	79.8	62.0	71.4	55.1
Other	75.4	66.9	83.6	77.1	84.2	80.3	83.6	74.8	83.3	74.9	80.8	72.7	75.8	67.8

a Cumulative coverage for dose 1 and dose 3 reported for adolescents aged 16–19 years. Cumulative coverage for dose 1 and dose 2 reported for adolescents aged 13–15 years after the HPV vaccination program changed from a three-dose schedule to a two-dose schedule in 2018 (2017 in New South Wales).
b Age assessed at 31 December 2019. Birth cohort for adolescents aged 12 years not included as 12 year olds are not eligible for HPV vaccination in some jurisdictions.
c Source: Australian Immunisation Register, data as at 29 February 2020.
d Not all 13 year olds in 2019 would have been offered HPV vaccine in their 2019 year level, notably those in South Australia and Western Australia.
e Coverage at age 15 years is the recommendation time point for coverage reporting between jurisdictions and over time.

Table 30: Coverage (%) for meningococcal ACWY vaccine by Aboriginal and Torres Strait Islander status, state and territory, and age[a] for vaccination encounters recorded up to 31 December 2019[b]

Aboriginal and Torres Strait Islander status	State or territory[c]								
	ACT	NSW	NT	Qld	SA	Tas.	Vic.	WA	Australia
16 year olds (cohort born 1 January to 31 December 2003)									
Aboriginal and Torres Strait Islander	62.4	64.9	77.1	66.2	46.6	78.5	59.8	68.2	66.1
Other	80.0	73.2	68.2	72.1	55.8	76.5	71.8	78.7	72.1
17 year olds (cohort born 1 January to 31 December 2002)									
Aboriginal and Torres Strait Islander	58.0	59.1	78.4	66.7	24.4	78.0	68.5	66.3	64.1
Other	81.1	72.3	66.7	70.0	16.4	77.2	75.9	76.2	69.5

a Age assessed at 31 December 2019. Adolescents aged 16 years (born in 2003) were the first cohort eligible for a funded meningococcal ACWY vaccine under the NIP in place since April 2019. Prior to this, adolescent meningococcal ACWY vaccination was funded by state/territories with the programs in place for varying times and for various eligible risk groups or age cohorts.

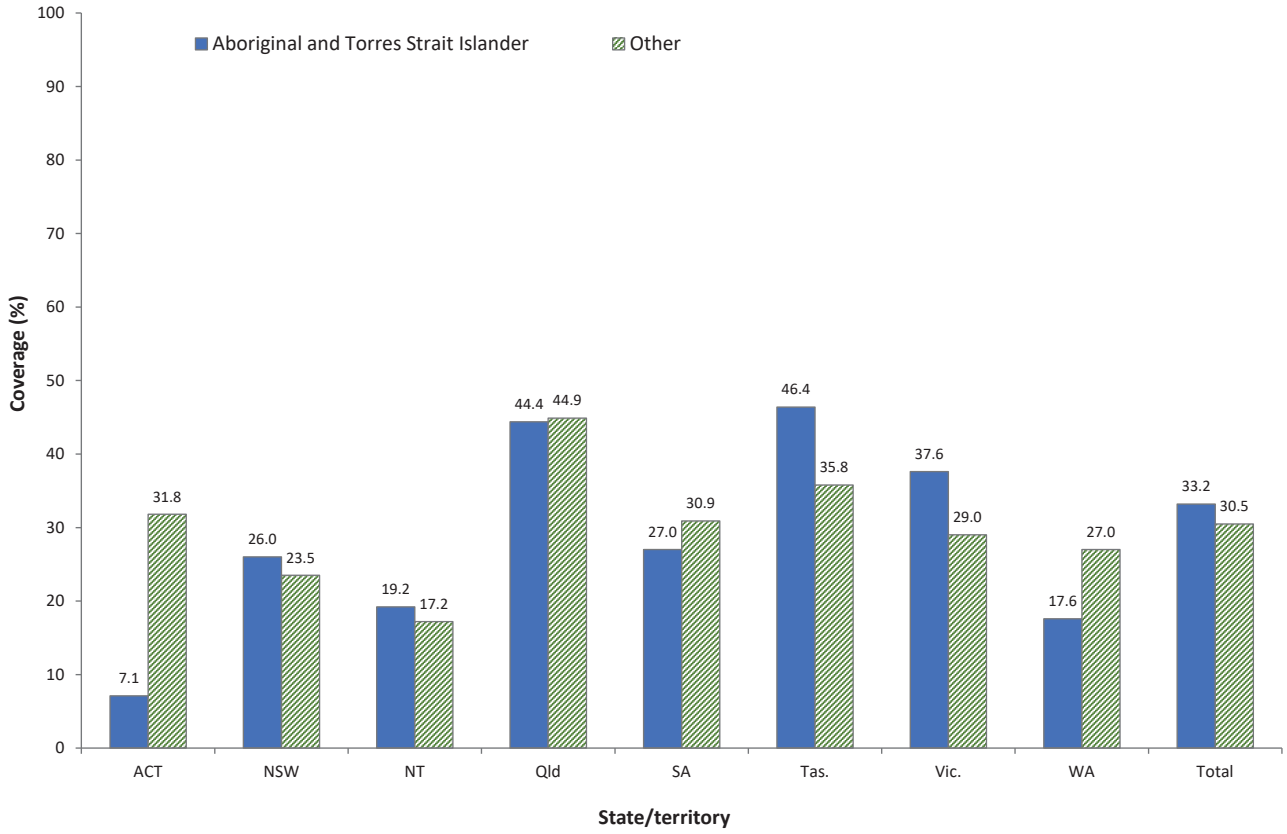
b Source: Australian Immunisation Register, data as at 31 March 2021.

c ACT: Australian Capital Territory; NSW: New South Wales; NT: Northern Territory; Qld: Queensland; SA: South Australia; Tas.: Tasmania; Vic.: Victoria; WA: Western Australia.

aged 6 months to 5 years increased substantially over the four-year reporting period, from 11.6% in 2016 to 43.6% in 2019, and now is very similar to uptake in other children (41.6%). Influenza vaccination is funded for all Aboriginal and Torres Strait Islander children aged 6 months and older, whereas it is only funded for non-Aboriginal and Torres Strait Islander children aged 6 months to 4 years with specified underlying medical conditions.

As Aboriginal and Torres Strait Islander children are more vulnerable to severe disease, timely vaccination, at the earliest appropriate age, remains an important public health goal. Most children do eventually complete the scheduled vaccination series, evident as 'fully vaccinated' coverage in Aboriginal and Torres Strait Islander children surpasses that of other children by the 60-month milestone. However, many Aboriginal and Torres Strait Islander children are still not vaccinated in a timely manner; and, despite improvements in on-time vaccination between 2016 and 2019, delayed vaccination has continued to be a persistent concern for Aboriginal and Torres Strait Islander children in Australia. For each vaccine assessed, the percentage of Aboriginal and Torres Strait Islander children vaccinated on-time was substantially lower than the percentage for other children. Further compounding the timeliness issue for Aboriginal and Torres Strait Islander children is the higher percentage receiving these vaccines very late (i.e. at ≥ 7 months after the schedule point) compared with other children. Key strategies aimed at closing the vaccination timeliness gaps, between Aboriginal and Torres Strait Islander and other children, have included: improving Aboriginal and Torres Strait Islander identification; contacting parents of Aboriginal and Torres Strait Islander children before the child's vaccination due date (pre-call notices); personalised vaccination calendars/applications; providing immunisation providers with tools to monitor timely coverage data for Aboriginal and Torres Strait Islander children; and promoting immunisation in local Aboriginal and Torres Strait Islander communities.[243,244] A dedicated Aboriginal Immunisation Healthcare Worker Program, funded by NSW Health since 2012, is proving to be an effective public health intervention in that state, improving the timeliness of Aboriginal and Torres Strait Islander childhood vaccinations.[245]

Figure 29: Zoster vaccination coverage for 70 –< 71 years, by state and territory,[a] and Aboriginal and Torres Strait Islander status, Australia, 2019[b]



a ACT: Australian Capital Territory; NSW: New South Wales; NT: Northern Territory; Qld: Queensland; SA: South Australia; Tas.: Tasmania; Vic.: Victoria; WA: Western Australia.

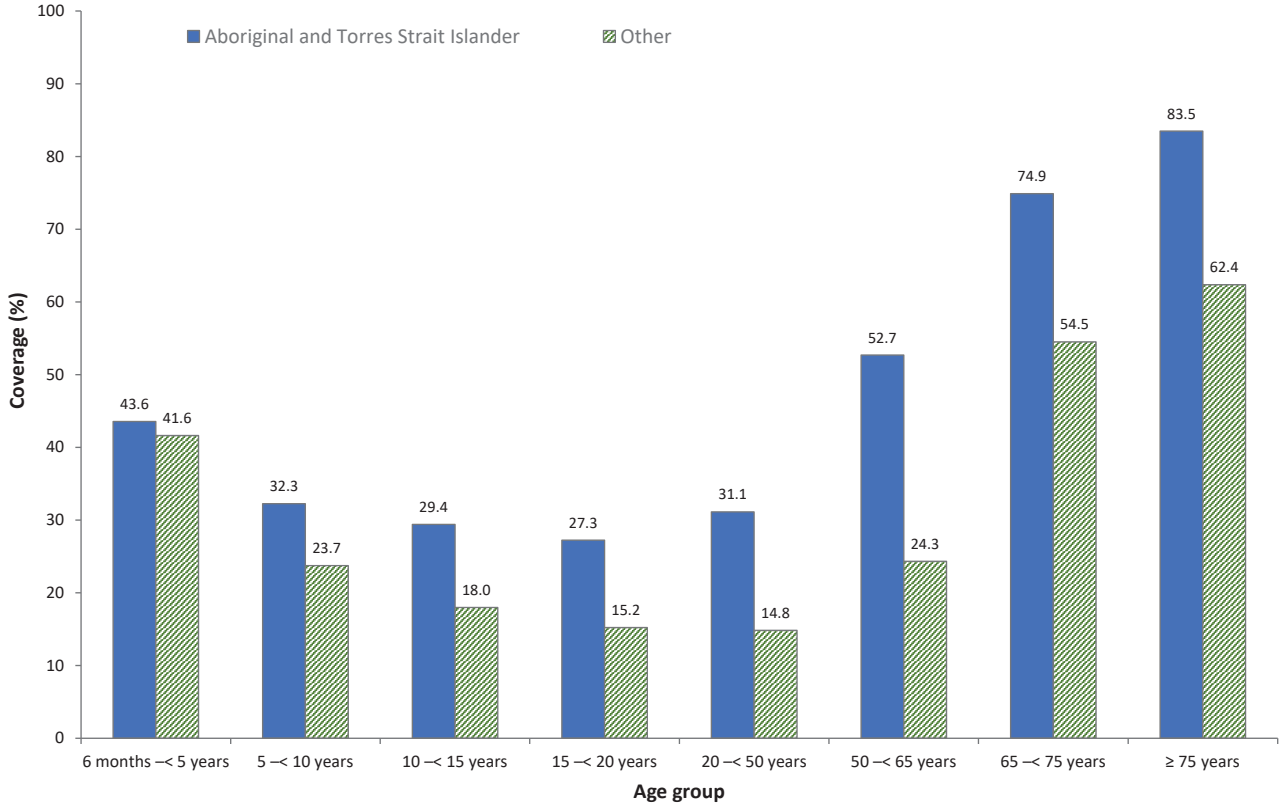
b Source: Australian Immunisation Register, data as at 31 March 2020.

Aboriginal and Torres Strait Islander adolescent and adult vaccination coverage data were presented for the first time in this series of reports. HPV vaccination coverage, now derived from the AIR rather than from the National HPV Vaccination Program Register as in earlier reports, is several percentage points higher among adolescent girls than among adolescent boys, for all birth cohorts and for both Aboriginal and Torres Strait Islander and other adolescents. Completion of the HPV vaccination schedule is lower in Aboriginal and Torres Strait Islander adolescents aged 15 years (77.9% for females, 71.8% for males) than in other adolescents (82.8% for females, 80.3% for males). With modelling of both sex HPV vaccination programs suggesting that sustained population vaccination coverage of over 80% will be sufficient for elimination of targeted HPV types, Australia looks well placed to achieve this.[246]

For adolescents aged 17 years, national coverage of the meningococcal ACWY vaccine was 64.1% among Aboriginal and Torres Strait Islander adolescents and 69.5% among other adolescents. Coverage in this age group varied by jurisdiction, reflecting the different programs in place and funded by states and territories, with the lowest coverage in South Australia for both Aboriginal and Torres Strait Islander (24.4%) and other (16.4%) adolescents. The low coverage in South Australia is likely due to the jurisdictional program being only for Aboriginal and Torres Strait Islander adolescents living in the Eyre and Far North, and Flinders and Upper North regions of South Australia.

Recorded zoster vaccination coverage in 2019 was slightly higher in Aboriginal and Torres Strait Islander 70-year-olds than in other adults, but still relatively low at 33.2%. While recorded

Figure 30: Recorded uptake of seasonal influenza vaccine[a] by age group, and Aboriginal and Torres Strait Islander status, Australia, 2019[b]



a Any influenza vaccine dose.

b Source: Australian Immunisation Register, data as at 31 March 2021.

influenza vaccine coverage was relatively high in older Aboriginal and Torres Strait Islander adults, at 74.9% for those aged 65 –< 75 years and 83.5% for 75 years and over, coverage in younger adults was suboptimal, ranging from 31.1% for those aged 20 –< 50 years to 52.7% for 50 –< 65 years. Further efforts to increase uptake are required, given that annual influenza vaccination is funded on the NIP for all Aboriginal and Torres Strait Islander adults, due to their increased risk of severe disease. However, influenza vaccine coverage was higher in Aboriginal and Torres Strait Islander adults in 2019 than in other adults, across all age groups, ranging from 16.3 percentage points higher for the 20 –< 50 year age group to 28.4 percentage points higher for the 50 –< 65 year age group. Influenza vaccination is only funded for non- Aboriginal and Torres Strait Islander adults aged 65 years and over or with specified underlying medical conditions. Zoster and influenza vaccine coverage data presented should be regarded as minimum estimates due to likely substantial under-reporting of adult vaccinations. Completeness of reporting is anticipated to improve following introduction of mandatory reporting in 2021.

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Appendix A: Technical notes on methods and interpretation of vaccine preventable diseases and vaccination coverage data

The methods used in this report are adapted from those used in the earlier reports in this series.[1–4]

General issues regarding data on vaccine preventable diseases

Three sources of routinely collected data were used for this report: notification data obtained from the National Notifiable Diseases Surveillance System (NNDSS); hospitalisation data obtained from the Australian Institute of Health and Welfare (AIHW) National Hospital Morbidity Database; and mortality data provided by the Australian Coordinating Registry.

Comparisons between the notification, hospitalisation and death data should be made with caution, since these datasets differ in their purposes of collection, reporting mechanisms and accuracy. As there are no unique identifying codes to link records for the same individuals across these datasets, and due to differences in defining a case and in the completeness and the accuracy of the data in each dataset, it is not possible to interpret deaths and hospitalisations as subsets of notifications.

Methodology used for the HPV section of this report differed from that used for other vaccine preventable diseases (VPDs), as HPV infection or HPV-related disease is not notifiable to NNDSS and death data is not an appropriate data source. Hospitalisation data is presented for genital warts in the HPV chapter; additionally, other key data from a variety of sources are summarised, including sentinel surveillance of the detection of HPV during cervical screening, rates of genital wart medical presentations, and rates of cervical precancer detected through screening.

Notifications

The NNDSS was established in its current form in 1991 and includes de-identified information about cases of notifiable diseases notified to state and territory authorities under their respective public health legislation. Prior to 2004, state and territory notification criteria were based on the National Health and Medical Research Council (NHMRC) surveillance case definitions, with various modifications applied in different jurisdictions. Since 2004, all jurisdictions have applied national case definitions for notifiable diseases endorsed by the Communicable Diseases Network Australia (CDNA).[247] The case definitions for notifications, for all included VPDs, are described on the Department of Health and Aged Care website.[247]

Disease notifications with a date of diagnosis between 1 January 2010 and 31 December 2019 were included in this report (data as of 1 February 2021). The data collected by the NNDSS are continually updated by jurisdictions. Due to the dynamic nature of the NNDSS, data on this extract are subject to retrospective revision and may vary from data reported in annual reports of the NNDSS (Australia's Notifiable Disease Status reports)[248] and in other reports that include national notifiable diseases data, depending on the date of data extraction.

The variables extracted for analysis of each disease were: diagnosis date; Aboriginal and Torres Strait Islander status; sex; age at diagnosis; birth date (MM/YYYY); and the state or territory from which the notification was received. Diagnosis date is a derived field in NNDSS based on the earliest of four dates: either the onset date or, where the onset was not known, the earliest of the specimen collection date, the notification date and the notification receive date. Data for specific serotypes/serogroups of the causal organism have been presented for invasive pneumococcal disease and invasive meningococcal disease.

Notification data are presented for invasive Hib disease, hepatitis A, acute hepatitis B, influenza,

measles, meningococcal disease, mumps, pertussis, pneumococcal disease and rotavirus in their respective chapters, and rare diseases (diphtheria, tetanus, poliomyelitis and rubella) in a combined chapter. Summary data are presented in Appendix C. HPV notification data are not presented, as this disease is not nationally notifiable to NNDSS. Notification data for varicella-zoster virus infections (chickenpox and herpes zoster) are not presented, due to a high proportion of non-specific notifications and a low level of completeness of Aboriginal and Torres Strait Islander status.

Aboriginal and Torres Strait Islander status identification in notification data

Aboriginal and Torres Strait Islander status in the notification data provided by the Department of Health includes three categories: 'Aboriginal and/or Torres Strait Islander origin', 'not Aboriginal or Torres Strait Islander origin' and 'not stated'. Aboriginal and/or Torres Strait Islander status is classified in this report under two categories: 'Aboriginal and Torres Strait Islander' (individuals identified as Aboriginal and/or Torres Strait Islander) and 'other' (individuals recorded as not Aboriginal or Torres Strait Islander plus those whose status was not stated or inadequately described).

The proportion of notifications that lack identification of Aboriginal and Torres Strait Islander status was examined by jurisdiction, year and disease. An acceptable level of completeness of Aboriginal and Torres Strait Islander status identification was defined as at least 70% in all states and territories for the diseases analysed. This level of completeness was achieved for Hib, hepatitis A, hepatitis B, measles, meningococcal disease, mumps, pneumococcal disease (invasive), diphtheria, tetanus, poliomyelitis and rubella over the period 2016–2019. After establishing that notification incidence estimates were not dominated by any one of the jurisdictions (data not shown), estimates are presented for all states and territories and age groups combined, except for influenza, pertussis and rotavirus. While 70% was deemed an acceptable level of completeness of Aboriginal and Torres Strait Islander status, incomplete identification may result in the rates reported underestimating the true incidence of disease in Aboriginal and Torres Strait Islander people. Hence, it is important to continue to strive for higher levels of completeness.

Notification data on influenza are presented only for the two states with acceptable completeness of Aboriginal and Torres Strait Islander status. Notification data for pertussis are presented only for the < 5 years age group, due to a low proportion of cases with recorded Aboriginal and Torres Strait Islander status in other age groups. Notification data for rotavirus are presented only for the < 5 years age group and for six states and territories, due to a large proportion of cases without a recorded Aboriginal and Torres Strait Islander status in other age groups and jurisdictions. These partial data were included on the basis of advice from the report's Advisory Group, given the importance of these diseases in Aboriginal and Torres Strait Islander people.

See Chapter 1 ('Aboriginal and Torres Strait Islander status completeness for vaccine preventable diseases in notification data, Australia, 2016–2019') for detailed analysis and discussion on Aboriginal and Torres Strait Islander status completeness in notification data.

Other issues to be noted when interpreting notification data

In general, notification data represent only a proportion of the total cases occurring in the community: that is, only those cases for which health care was sought, a test conducted and a diagnosis made, followed by a notification to health authorities. An infectious disease which is diagnosed by a laboratory test is more likely to be notified than if it is diagnosed only on clinical grounds. The degree of under-representation of all cases is unknown and is most likely variable by disease and jurisdiction.[248]

In interpreting these data, it is important to note that changes in notifications over time may not solely reflect changes in disease prevalence or incidence. Depending on the disease, the number of notifications that occur annually may be influenced by changes in testing policies; by screening programs including the preferential testing of high risk populations; by the use of less invasive and more sensitive diagnostic tests; and by periodic awareness campaigns.

Hospitalisations

The AIHW National Hospital Morbidity Database has received administrative, demographic and clinical information about patients admitted to public and private hospitals in Australia since 1993. Almost all hospitalisation episodes in public and private hospitals are captured.[6] Similar to the previous report, hospitalisations were characterised based on date of admission rather than on date of separation.[1]

Based on the published recommendations of the AIHW, which states that all jurisdictions are to be included in the national analysis of Aboriginal and Torres Strait Islander hospitalisation data from 2010–2011 onwards,[5] all states and territories were included in hospitalisation analyses for the period 2016 to 2019. For trend reporting for the period 2010 to 2019, the six jurisdictions (all except Tasmania and the Australian Capital Territory) that met Aboriginal and Torres Strait Islander reporting standards were included on the basis of AIHW recommendations.[5,6] The analysis of hospitalisation rates over time should be interpreted with caution, as hospitalisation rates for Aboriginal and Torres Strait Islander patients may be affected to a varying degree by improved identification over the period being analysed.[12,249] To comply with the AIHW's data release condition that hospitalisation counts < 5 be suppressed in published reports, counts between 1 and 4 are reported as a range. Data were extracted based on the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification (ICD-10-AM) codes. The codes used to select the specific condition(s) for reporting of each of the included vaccine preventable diseases are described in Appendix B. Eligible admissions included those with the code of interest listed in the principal diagnosis (the diagnosis chiefly responsible for the episode of hospital admission) or in any other additional diagnosis fields (i.e. conditions or complaints either coexisting with the principal diagnosis or arising during the episode of care). For hepatitis B, only hospitalisation records with acute hepatitis B as the principal diagnosis were included, consistent with previous practice in this report series.[1–4] For poliomyelitis, only hospitalisation records with acute poliomyelitis as the principal diagnosis were included, due to likely miscoding of hospitalisations relating to post-polio syndrome sequelae.

In this report, disease hospitalisations with a date of admission between 1 January 2010 and 30 June 2019 were included (data as of 1 February 2021). The 2019 hospitalisation data was annualised. The variables extracted for analysis of each disease were: age at admission; state or territory of residence; Aboriginal and Torres Strait Islander status; year of admission; and separation (discharge) diagnoses (principal and additional diagnoses [up to 50 diagnoses]).

Hospitalisation data are presented for hepatitis A, acute hepatitis B, influenza, measles, mumps, pertussis, rotavirus and varicella-zoster infections (chickenpox and herpes zoster, separately) in their respective chapters, and for rare diseases (diphtheria, tetanus, poliomyelitis, and rubella) in a combined chapter. Summary data are presented in Appendix C. No hospitalisation data are presented for invasive Hib disease, as there is no type-specific code for invasive Hib disease within the ICD-10-AM classification system. Detailed hospitalisation data for invasive meningococcal disease are not presented, due to known problems with interpretation due to readmissions. Invasive pneumococcal disease hospitalisation data are not presented, due to limitations in accurately identifying cases of IPD using discharge diagnosis codes. Hospitalisation data is presented for genital warts in the HPV chapter.

Aboriginal and Torres Strait Islander status identification in hospitalisation data

Aboriginal and Torres Strait Islander status in hospitalisation data provided by the Australian Institute for Health and Welfare (AIHW) includes two categories: 'Indigenous Australians' (referred to in this report as Aboriginal and Torres Strait Islander) and 'other Australians' (includes individuals recorded as not Aboriginal or Torres Strait Islander plus those whose status was not stated or inadequately described).

Other issues to be noted when interpreting hospitalisation data

Hospitalisations generally represent the more severe end of the morbidity spectrum of a disease, and the extent to which ICD-coded hospitalisation data reflect the burden of the disease of interest varies between diseases.

There are also limitations associated with the use of ICD codes to identify cases. Errors that cause the ICD code to differ from the true disease include both random and systematic measurement errors. These errors may occur either along the patient pathway (e.g. level of details documented in medical records, clinicians' experience) or along the paper trail (e.g. transcribing errors, coder errors such as misspecification, unbundling [assigning codes for all the separate parts of a diagnosis rather than for the overall diagnosis] and upcoding [using reimbursement values to determine the order of coding]).[250] It is difficult to gauge the relative importance of hospitalisations where the coded disease of interest was not the principal diagnosis but was recorded as an additional diagnosis for that hospitalisation episode.

In the National Hospital Morbidity Database, there is one record for each hospital admission/separation episode. This means that there are separate records for each readmission, change in care type or inter-hospital transfer. This is unlikely to have a major impact on the numbers reported for most diseases reviewed in this report, as they are mostly acute illnesses, but the implications of the potential but unquantified impact of this limitation need to be considered for each VPD individually.

Hospitalisation data may also be affected by variations in admission practices over time, between public and private sectors, and across states and territories.[6] Variation in availability and access to hospitals across different geographic regions should also be noted when comparing and interpreting hospitalisation data for different population groups.

Deaths

The registration of deaths is the responsibility of the eight individual state and territory Registrars of Births, Deaths and Marriages. As part of the registration process, information on the cause of death is supplied by the medical practitioner certifying the death, or by a coroner. The information is provided by individual Registrars to the Australian Bureau of Statistics (ABS) for coding and compilation into aggregate statistics. In addition, the ABS supplements this data with information from the National Coroners Information System.[251]

Since 1997, the International Classification of Diseases, 10th Revision (ICD-10) has been used to identify the cause of death. The problems associated with the accuracy of ICD coding used for hospital admissions, discussed under *Hospitalisations*, may also be relevant for mortality data. The codes used to select the specific condition(s) for reporting of each of the included VPDs are described in Appendix B.

Unit file records of registered deaths from the Australian Coordinating Registry were available for analysis for this report. Following advice received from the Australian Bureau of Statistics via the Australian Coordinating Registry (ACR),[i] all jurisdictions were included in the reporting of death data. To comply with

i Personal communication, Bernadette Ryan, Coordinator, Australian Coordinating Registry, June 2017.

the ACR's data release condition that death counts < 6 be suppressed in published reports, counts between 1 and 5 are reported as a range.

This report includes data on death records where the disease of interest was documented as either the 'underlying cause of death' (i.e. the single disease that 'initiated the train of morbid events leading directly to death') or where a disease was one of the multiple causes of death (i.e. 'either the underlying cause, the immediate cause or any intervening causes, and those conditions which contributed to death but were not related to the disease or condition causing death').[251] In this report, deaths where the disease was one of the multiple causes, but not the underlying cause, are referred to as an 'associated' cause. In keeping with the methods used in relation to poliomyelitis and hepatitis B hospitalisations, only deaths for which poliomyelitis/hepatitis B was the underlying cause were included in this report.

Aboriginal and Torres Strait Islander status identification in death data

Aboriginal and Torres Strait Islander status in the death data provided by the Australian Coordinating Registry includes three categories: 'Indigenous', 'non-Indigenous' and 'not stated'. Aboriginal and/or Torres Strait Islander status is classified in this report under two categories: 'Aboriginal and Torres Strait Islander' (individuals identified as 'Indigenous') and 'other' (individuals recorded as 'non-Indigenous' plus those who status was not stated or was inadequately described).

Other issues to be noted when interpreting death data

Mortality data are reported and analysed by the year in which the death occurred. This differs from previous reports in which the year of death registration was used. This may result in incomplete data for the latest available year (although less than 5% of deaths are registered in the subsequent year, the bulk of which are deaths that occurred in December of that calendar year).

In Australia, information on the cause of death is reported routinely for every death on a standard Medical Certificate of Cause of Death completed by a medical practitioner or a coroner. The person completing the certificate must nominate the underlying (principal) cause of death and any associated conditions.[252] The accuracy in ascertaining the cause of death may vary according to the experience of the practitioner, the complexity of the disease process, the circumstances of the death, and whether post-mortem autopsy was performed. Studies comparing clinical and autopsy diagnoses have found that infectious diseases were not uncommonly a missed or discordant diagnosis, although vaccine preventable diseases were not specifically identified.[253] In the case of pertussis and tetanus, studies have documented that deaths due to these diseases, which can be otherwise identified through disease surveillance systems and hospitalisation records, sometimes go unrecorded on death certificates.[254,255]

Calculations and statistical methods

Calculation of rates

All rates were calculated using the mid-year estimated resident populations released by the ABS as the population denominator. Rates are presented as annual rates or average annual rates per 100,000 total population, or per 100,000 population by Aboriginal and Torres Strait Islander status and age group as appropriate. Age groups analysed for each disease were unchanged from the previous report.[1] In addition, notification and hospitalisation data on influenza, pertussis and rotavirus were also presented for infants younger than 6 months and infants aged between 6 and 12 months, on the basis of advice from the report's Advisory Group, given the importance of these diseases in Aboriginal and Torres Strait Islander infants.

Age-standardised rates by Aboriginal and Torres Strait Islander status, for all age groups in aggregate, are presented for data for the 2016–2019 period, and for varicella and zoster hospitalisation trend data. The direct

standardisation method was used to calculate rates for all age groups combined, using the ABS 2016 population estimates as the standardising population. Interpretation and comparison of the standardised rates for each disease between Aboriginal and Torres Strait Islander and 'other' Australians should take into account the limitations of age-standardised rates in representing the overall disease burden, including the issues arising from small number of events, age distribution of events, misclassification, population size and distribution, and under-identification of Aboriginal and Torres Strait Islander status. Accordingly, rates were not standardised when case numbers were less than 20.[256]

Rate ratios for Aboriginal and Torres Strait Islander versus other Australians were calculated, including age-specific rate ratios, where appropriate.

SAS version 9.4 was used for statistical analysis and STATA version 14 to calculate 95% confidence intervals for rates.

Population denominators for calculation of rates

For notification and hospitalisation data, all rates were calculated using the mid-year estimated resident populations for the corresponding calendar year for the respective age group and/or state or territory as the population denominator. Estimates from the ABS Estimates and Projections, Aboriginal and Torres Strait Islander Australians, 2006 to 2031 (based on the 2016 Census) were used as the population denominators for calculations of rates for Aboriginal and Torres Strait Islander people.[8]

The population denominators for calculation of rates for 'other' Australians were derived by subtracting the corresponding estimates for Aboriginal and Torres Strait Islander population of the relevant jurisdictions and age groups from the estimates of the total ABS-estimated resident population as at June of the corresponding year, based on latest estimates as per 2016 census data.[257]

Vaccination coverage

Measuring vaccination coverage and vaccination timeliness in children

Using AIR data to 31 March 2020, this report details vaccination coverage estimates between 2016 and 2019, with 3-month birth cohorts used for the 2016–2019 time-trend analyses and 12-month-wide cohorts (children born between 1 January and 31 December for each respective 12-month period) used for all other analyses. The cohort method has been used for calculating vaccination coverage at the population level (national and state/territory) since the AIR's inception.

Cohort vaccination status was assessed at 12 months of age (for vaccines due at 6 months), 24 months of age (for vaccines due at 12 and 18 months) and 60 months of age (for vaccines due at 48 months). A minimum 3-month lag period was allowed for late notification of vaccinations to the AIR, but only vaccines given on or before a child's first, second or fifth respective birthdays were included in the coverage calculations.[258] If a child's records indicate receipt of the last dose of a vaccine that required more than one dose to complete the series, it was assumed that earlier vaccines in the sequence had been given. This assumption has been shown to be valid in the past.[259,260]

The percentage of children designated as 'fully vaccinated' was calculated using the number of children completely immunised with the vaccines of interest by the designated age as the numerator and the total number of Medicare-registered children in the age cohort as the denominator. Aboriginal and Torres Strait Islander status is recorded on the AIR as 'Aboriginal and Torres Strait Islander', 'non-Indigenous' or 'unknown' and is as reported by the child's carer to Medicare, or by the immunisation provider to the AIR. For the purposes of analysis in this report, children whose Aboriginal and Torres Strait Islander status was unknown were combined with non-Indigenous children into an 'other' category.

The completeness of Aboriginal and Torres Strait Islander identification was 98.7% (i.e. 1.3% unknown Aboriginal and Torres Strait islander status) in 2020.

'Fully vaccinated' at 12 months of age was defined as a child having a record on the AIR of three doses of a diphtheria (D), tetanus (T) and pertussis–containing (P) vaccine; three doses of a polio vaccine; two or three doses of a PRP-OMP containing *Haemophilus influenzae* type b (Hib) vaccine or three doses of any other Hib vaccine; three doses of hepatitis B vaccine; and two or three doses of 13-valent pneumococcal conjugate vaccine.

'Fully vaccinated' at 24 months of age was defined as a child having a record on the AIR of a dose of meningococcal C vaccine; a dose of varicella vaccine; and two doses of a measles-containing vaccine (given as either MMR or MMRV), in addition to four doses of diphtheria-tetanus-pertussis; three doses of hepatitis B and polio vaccines; and three or four doses of PRP-OMP Hib, Infanrix hexa or Hiberix vaccine (three doses only of Infanrix Hexa or Hiberix if given after 11.5 months of age), or four doses of any other Hib vaccine. 'Fully vaccinated' at 60 months of age was defined as a child having a record on the ACIR of four or five doses of a DTP-containing vaccine and four doses of a polio vaccine.

Vaccination coverage estimates were also calculated for the individual NIP vaccines given in childhood that are not part of the 'fully vaccinated' calculations at 12, 24 and 60 months of age. These included the second dose of hepatitis A vaccine and a fourth (booster) dose of pneumococcal vaccine for Aboriginal and Torres Strait Islander children by 30 months of age; and an annual dose of seasonal influenza vaccine for Aboriginal and Torres Strait Islander children aged 6 months to < 5 years.

Age-appropriate and on-time vaccination was defined as receipt of a scheduled vaccine dose within 30 days of the recommended age. The delay outcome measure for each dose is categorised as either 'on-time', 'delay of 1 –≤ 2 months', 'delay of 3 –≤ 6 months' or 'delay ≥ 7 months'. Children included in the 12-month birth cohorts for the timeliness analyses were assessed at 1–3 years after the doses were due to allow time for late vaccinations to be recorded.

Vaccination coverage and vaccination delay estimates are presented in this report for Australia, as well as by jurisdiction (state/territory). Additional analysis for small areas was done by ABS-defined Statistical Area 4 (SA4),[261] chosen because each is small enough to show differences within jurisdictions but not too small to render maps unreadable. Maps were created using version 15 of the MapInfo mapping software[262] and the ABS Census Boundary Information. As postcode is the only geographical indicator available from the AIR, the ABS Postal Area to SA4 Concordance 2011 was used to match AIR postcodes to SA4s.[263] The Accessibility/Remoteness Index of Australia (ARIA++)[264] was used to define the area of residence as 'Major cities', 'Inner regional', 'Outer regional', 'Remote' and 'Very remote'. ARIA++ is a continuous varying index, with values ranging from 0 (high accessibility) to 15 (high remoteness), and is based on road distance measurements from over 12,000 populated localities to the nearest Service Centre in five categories based on population size. For this report, the two 'Regional' categories ('Inner regional' and 'Outer regional' were combined into one category and the two 'Remote' categories ('Remote' and 'Very remote') were combined into one category. ARIA Accessibility/Remoteness categories were assigned for each child using their current recorded postcode of residence on the AIR.

Measuring vaccination coverage in adolescents

HPV vaccination in Australia is delivered routinely in early high school, usually around the age of 12–13 years. Therefore, all adolescents have had the opportunity to complete the vaccination course by age 15 years. HPV vaccination coverage was calculated by birth

cohort using the number of adolescents aged 13 to 18 years in 2019 (i.e those born in 2006 to 2001 respectively) recorded on the AIR to have received dose 1, dose 2 and/or dose 3 of the HPV vaccine by 31 December 2019, respectively as the numerator, and using the total number of Medicare-registered adolescents in each cohort in 2019 in AIR as the denominator. The 2019 15-year-old cohort (those born in 2004) was the first cohort to include some students eligible for the two-dose schedule after the change from a three-dose schedule in 2018. HPV vaccination coverage and course completion analysis was undertaken by year, gender and Aboriginal and Torres Strait Islander status.

Adolescent meningococcal ACWY vaccination coverage was calculated using the number of 16- and 17-year old adolescents in 2019 (i.e. those born in 2003 and 2002 respectively) recorded on the AIR to have received a booster dose of meningococcal ACWY vaccine by 31 December 2019, as the numerator, and the total number of Medicare- registered adolescents in the cohorts aged 16 or 17 years in 2019 in AIR as the denominator. Analysis was undertaken by Aboriginal and Torres Strait Islander status, birth cohort and jurisdiction.

Measuring vaccination coverage in adults

Adult zoster vaccination coverage was calculated using the number of 70 –< 71 year olds in 2019 recorded on the AIR to have received a dose of zoster vaccine by 31 December 2019 as the numerator, and the total number of Medicare-registered adults aged 70 –< 71 years in 2019 in AIR as the denominator. Analysis was undertaken by Aboriginal and Torres Strait Islander status and state/territory.

Measuring influenza vaccination coverage among children, adolescents and adults

Influenza vaccination coverage was calculated by age group (6 months to < 5 years, 5 to < 10 years, 10 to < 15 years, 15 to < 20 years, 20 to < 50 years, 50 to < 65 years, 65 to < 75 years and ≥ 75 years) by dividing the number of adults in the relevant age group with at least one dose of influenza vaccine recorded on AIR in the 2019 by the total number of those in the relevant age group registered on AIR in 2019, by Aboriginal and Torres Strait Islander status and jurisdiction.

Literature search strategy

An information specialist completed literature searches for each vaccine preventable disease in two key databases: Ovid Medline (All including Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions, 1946–current) and Ovid Embase (1974–current). These expanded upon and were updated from the date of searches completed for the previous report.[1] The searches utilised both controlled vocabulary and corresponding textword terms. The searches were structured to combine immunisation and vaccination terms (including vaccination coverage), with the disease topic, Australia and Australian state and territory name terms, and First Nations terms.

Appendix B: ICD-10 codes used for hospitalisations and deaths

Disease	ICD-10-AM/ICD-10 code
Diphtheria	A36 (diphtheria)
Hepatitis A	B15 (hepatitis A)
Hepatitis B (acute)	B16 (acute hepatitis B)
Hib disease	There were no ICD-10-AM/ICD-10 codes which specified Hib as a causative organism. The ICD-10-AM/ICD-10 code used to identify presumed Hib cases was G00.0 (haemophilus meningitis). (The ICD-10-AM/ICD-10 codes for *H. influenzae* pneumonia, *H. influenzae* septicaemia, *H. influenzae* infection and acute epiglottitis were not included as these were considered insufficiently specific for invasive *H. influenzae* type b disease)
Human papillomavirus	Hospitalisations: A63.0 (anogenital (venereal) warts)
Influenza	J09 (influenza due to certain identified influenza viruses) J10 (influenza due to identified influenza virus) J11 (influenza, virus not identified)
Measles	B05 (measles)
Meningococcal disease	A39 (meningococcal infection). This includes meningococcal meningitis (A39.0), Waterhouse-Friderichsen syndrome (A39.1), acute meningococcaemia (A39.2), chronic meningococcaemia (A39.3), meningococcaemia unspecified (A39.4), meningococcal heart disease (A39.5), other meningococcal infections (A39.8), and meningococcal infection unspecified (A39.9)
Mumps	B26 (mumps)
Pertussis	A37 (whooping cough)
Pneumococcal disease	Deaths: G00.1 (pneumococcal meningitis), A40.3 (pneumococcal septicaemia), J13 (pneumococcal pneumonia)
Poliomyelitis (principal)	A80 (acute poliomyelitis)
Rotavirus	A08.0 (rotaviral enteritis)
Rubella	B06 (rubella [German measles])
Tetanus	A33 (tetanus neonatorum) A34 (obstetrical tetanus) A35 (other tetanus)
Varicella	B01 (chickenpox)
Zoster	B02 (zoster [shingles])

Appendix C: Summary of notifications in Australia, for vaccine preventable diseases, 2016 to 2019,[a] by Aboriginal and Torres Strait Islander status

Disease[b]	Aboriginal and Torres Strait Islander status	N	Notification rate[c] (2016–2019)	Rate ratio (standardised) (95% confidence interval)
Diphtheria	Aboriginal and Torres Strait Islander	3	0.13	4.1 (1.0–11.0)
	Other	31	0.03	
Hib disease (invasive)	Aboriginal and Torres Strait Islander	22	0.59	10.9 (5.9-18.3)
	Other	51	0.05	
Hepatitis A	Aboriginal and Torres Strait Islander	16	0.45	0.4 (0.2-0.7)
	Other	1,026	1.08	
Hepatitis B	Aboriginal and Torres Strait Islander	58	2.12	3.7 (2.8-4.8)
	Other	554	0.57	
Influenza	Aboriginal and Torres Strait Islander	4,555	633.4	1.5 (1.5–1.6)
	Other	43,518	410.1	
Mumps	Aboriginal and Torres Strait Islander	1,466	36.98	36.9 (33.9-40.2)
	Other	956	1.0	
Measles	Aboriginal and Torres Strait Islander	12	0.29	0.49 (0.2-0.9)
	Other	556	0.59	
Meningococcal disease	Aboriginal and Torres Strait Islander	170	3.53	3.5 (2.9-4.3)
	Other	950	1.00	
Pertussis	Aboriginal and Torres Strait Islander	636	168.46	1.4 (1.3-1.6)
	Other	6,979	118.0	
Pneumococcal disease	Aboriginal and Torres Strait Islander	916	37.32	5.2 (4.9-5.5)
	Other	6,956	7.21	
Poliomyelitis	Aboriginal and Torres Strait Islander	0	0	—
	Other	0	0	
Rotavirus	Aboriginal and Torres Strait Islander	342	412.8	1.8 (1.6-2.0)
	Other	2,102	230.0	
Rubella	Aboriginal and Torres Strait Islander	1	0.03[d]	—
	Other	57	0.06	
Tetanus	Aboriginal and Torres Strait Islander	0	0.00	—
	Other	17	0.02	

a Notifications where the date of diagnosis was between 1 January 2016 and 31 December 2016. Rotavirus became nationally notifiable in mid-2018 so notifications where the date of diagnosis was between 1 July 2018 and 31 December 2016 were included for rotavirus.

b Influenza data presented for two states and territories (Western Australia and the Northern Territory); pertussis data presented for under 5 years of age only; rotavirus data presented for under 5 years of age only for six states and territories (Australian Capital Territory, Northern Territory, Queensland, South Australia, Tasmania and Western Australia). Varicella zoster excluded due to the high proportion of notifications unspecified. HPV excluded as not notifiable.

c Rates are per 100,000 per year for all ages combined, age-standardised to the Australian Bureau of Statistics Australian population estimates for 2016.

d Rate not standardised due to low number of Aboriginal and Torres Strait Islander cases.

Appendix D: Summary of hospitalisations in Australia, for vaccine preventable diseases, 2016 to 2019,[a] by Aboriginal and Torres Strait Islander status

Disease[b]	Aboriginal and Torres Strait Islander status	Hospitalisations		
		N	Rate[c]	Rate ratio (95% confidence interval)
Diphtheria	Aboriginal and Torres Strait Islander	6	0.18	3.3 (1.0–8.1)
	Other	46	0.05	
Hepatitis A	Aboriginal and Torres Strait Islander	46	1.96	1.3 (0.9-1.6)
	Other	1,289	1.53	
Hepatitis B	Aboriginal and Torres Strait Islander	29	1.06	3.1 (2.0–4.4)
	Other	291	0.35	
Influenza	Aboriginal and Torres Strait Islander	5,635	261.5	2.1 (2.0–2.1)
	Other	106,617	126.2	
Measles	Aboriginal and Torres Strait Islander	5	0.16	0.6 (0.2-1.6)
	Other	218	0.26	
Mumps	Aboriginal and Torres Strait Islander	102	3.20	7.2 (5.7-9.1)
	Other	370	0.44	
Pertussis	Aboriginal and Torres Strait Islander	193	5.35	2.4 (2.0–2.8)
	Other	1,841	2.24	
Poliomyelitis (principal)	Aboriginal and Torres Strait Islander	0	0.00	—
	Other	6	0.007	
Rotavirus	Aboriginal and Torres Strait Islander	518	12.30	2.8 (2.5–3.1)
	Other	3,627	4.42	
Rubella	Aboriginal and Torres Strait Islander	1-4[d]	0.02	No rate ratio
	Other	56	0.07	
Tetanus	Aboriginal and Torres Strait Islander	1-4[d]	0.06	No rate ratio
	Other	62	0.07	
Varicella	Aboriginal and Torres Strait Islander	107	4.27	1.3 (1.0–1.5)
	Other	2,848	3.38	
Zoster	Aboriginal and Torres Strait Islander	521	29.60	1.0 (0.9-1.0)
	Other	27,260	31.07	

a Hospitalisations where the date of admission was between 1 January 2016 and 30 June 2019. 2019 hospitalisation data was annualised.

b Hib hospitalisation and death data excluded due to no type-specific code available. Pneumococcal disease hospitalisation data excluded due to limitations identifying pneumococcal disease using discharge diagnosis codes. Meningococcal disease hospitalisation data excluded due to known problems with interpretation due to readmissions.

c Rates are per 100,000 populations for all ages combined, age-standardised to the Australian Bureau of Statistics Australian population estimates for 2016.

d To comply with the AIHW's data release condition that hospitalisation counts < 5 be suppressed in published reports, counts between 1 and 4 are reported as a range.

Appendix E: Summary of the National Immunisation Program Schedule and vaccination coverage estimates, by milestone age and vaccine, for Aboriginal and Torres Strait Islander children, adolescents and adults, Australia, 2019

Vaccine	National Immunisation Program Schedule (2019) (dose 1, dose 2, dose 3, etc.)	Milestone age for vaccination coverage	Current reporting period coverage (2019)
Children			
Diphtheria-tetanus- acellular pertussis	2 months, 4 months, 6 months, 18 months, 48 months	12 months (dose 3)	93.2
		24 months (dose 4)	91.5
		60 months (dose 4 or 5)	97.4
Polio	2 months, 4 months, 6 months, 48 months	12 months (dose 3)	93.1
		24 months (dose 3)	97.1
		60 months (dose 4)	97.0
Haemophilus influenzae type b	2 months, 4 months, 6 months, 18 months	12 months (dose 3)	93.1
		24 months (dose 4)	94.6
Hepatitis B	Birth, 2 months, 4 months, 6 months	12 months (dose 3)	93.1
		24 months (dose 3)	97.1
Measles-mumps-rubella	12 months, 18 months[a]	24 months (dose 1)	96.6
		24 months (dose 2)	92.9
		60 months (dose 2)	98.9
Varicella	18 months[a]	24 months (dose 1)	92.7
		60 months (dose 1)	98.8
Meningococcal C	12 months (until 2018)	24 months (dose 1)	96.6
Meningococcal ACWY	12 months	24 months (dose 1)	95.0
13-valent pneumococcal conjugate	2 months, 4 months, 6 months, 12 months	12 months (dose 2 or 3)	97.0
		24 months (dose 3)	96.7
		30 months (dose 4)	62.0
Rotavirus	2 months, 4 months	12 months (dose 2)	87.3
Hepatitis A[b]	12 months, 18 months	30 months (dose 2)	72.2
Adolescents (predominantly via school programs)			
HPV	12 –< 15 years	15 years (dose 1) 15 years (dose 2)	87.8 (girls) 83.0 (boys) 77.9 (girls) 71.8 (boys)
Meningococcal ACWY	14 –< 16 years	16 years	66.1
Adults			
Herpes zoster	70 years	71 years	33.2
Influenza vaccination – all ages			
Influenza	Annual vaccination for all Aboriginal and Torres Strait Islander people aged ≥ 6 months	6 months to < 5 years 5 –< 10 years 10 –< 15 years 15 –< 20 years 20 –< 50 years 50 –< 65 years 65 –< 75 years ≥ 75 years	43.6 32.3 29.4 27.3 31.1 52.7 74.9 83.5

a MMRV vaccine given at 18 months.

b Aboriginal and Torres Strait Islander children only in the Northern Territory, Queensland, South Australia and Western Australia.