

## Annual reports

# ANNUAL IMMUNISATION COVERAGE REPORT, 2010

Brynley Hull, Aditi Dey, Rob Menzies, Peter McIntyre

## Abstract

This, the fourth annual immunisation coverage report, documents trends during 2010 for a range of standard measures derived from Australian Childhood Immunisation Register (ACIR) data. These include coverage at standard age milestones and for individual vaccines included on the National Immunisation Program (NIP). For the first time, coverage from other sources for adolescents and the elderly are included.

The proportion of children 'fully vaccinated' at 12, 24 and 60 months of age was 91.6%, 92.1% and 89.1% respectively. For vaccines available on the NIP but not currently assessed for 'fully immunised' status or for eligibility for incentive payments (rotavirus and pneumococcal at 12 months and meningococcal C and varicella at 24 months) coverage varied. Although pneumococcal vaccine had similar coverage at 12 months to other vaccines, coverage was lower for rotavirus at 12 months (84.7%) and varicella at 24 months (83.0%). Overall coverage at 24 months of age exceeded that at 12 months of age nationally and for most jurisdictions, but as receipt of varicella vaccine at 18 months is excluded from calculations, this represents delayed immunisation, with some contribution from immunisation incentives. The 'fully immunised' coverage estimates for immunisations due by 60 months increased substantially in 2009, reaching almost 90% in 2010, probably related to completed immunisation by 60 months of age being introduced in 2009 as a requirement for GP incentive payments. As previously documented, vaccines recommended for Indigenous children only (hepatitis A and pneumococcal polysaccharide vaccine) had suboptimal coverage at around 57%. Delayed receipt of vaccines by Indigenous children at the 60-month milestone age improved from 56% to 62% but the disparity in on-time vaccination between Indigenous and non-Indigenous children at earlier age milestones did not improve. Coverage data for human papillomavirus (HPV) from the national HPV register are consistent with high coverage in the school-based program (73%) but were lower for the catch-up program for women outside school (30-38%). Coverage estimates for vaccines on the NIP from 65 years of age were comparable with other developed countries.

Keywords: immunisation coverage, immunisation delay, small area coverage reporting, human papilloma virus vaccine coverage

## Introduction

This is the fourth Annual Immunisation Coverage Report, following the first on 2007 data published in 2009.<sup>1</sup> This series of annual reports was established to consolidate the various forms of regular coverage reports and ad-hoc publications produced by the National Centre For Immunisation Research and Surveillance (NCIRS) using ACIR data, highlighting important trends and significant issues over the preceding 12 months.<sup>1-16</sup> It follows the format of the previous reports, providing a detailed summary for 2010 that includes vaccination coverage at standard milestone ages. It also includes coverage for vaccines not included in standard coverage assessments, timeliness of vaccination, coverage for Indigenous children and data for small geographic areas on vaccination coverage and prevalence of conscientious objectors. This report includes data on adolescents for the first time and the elderly age groups not on the ACIR, from previously published sources. Readers are referred to the first report for a more detailed explanation of the background to this series of annual reports and the range of analyses presented.<sup>1</sup> This report uses the longstanding international practice of reporting coverage at key milestone ages, to measure coverage against national targets and to track trends over time. No new vaccines were introduced to the NIP during 2010. However, in late 2009 in the Northern Territory, the 10-valent pneumococcal conjugate vaccine at 2, 4, 6 and 12 months of age replaced the 7-valent conjugate (7vPCV) and 23-valent polysaccharide (23vPPV) vaccines.

## Incentives for vaccination and reporting to the ACIR

The Australian Government, through the Department of Health and Ageing, advises the ACIR whether calculation of coverage of the new vaccines/antigens should be included in the completed schedule assessment for eligibility for payments to parents or immunisation providers. The ACIR makes information payments (up to \$6) to all immunisation

providers and general practitioners (GPs). Payments to GPs for the provision of data to the ACIR have been in place since its inception in 1996. In the 2008-09 Budget, the Australian Government announced that one of the components of the General Practice Immunisation Incentives Scheme (GPII), the GPII Service Incentive Payment (SIP), would stop from 1 October 2008. SIP payments of \$18.50 were made to GPs for reporting a vaccination which completed a schedule point on the NIP, at 6, 12, 18 months and 60 months.<sup>17</sup> However, the GPII Outcomes Payments,\* which paid practices that achieved 90 per cent or greater levels for full immunisation, were maintained. The vaccines/antigens required for full immunisation in assessment for the outcomes payment in 2010 were the same as in recent years, ie. diphtheria, *Haemophilus influenzae* type b (Hib), hepatitis B, measles, mumps, pertussis, polio, rubella and tetanus. Vaccines included on the NIP in 2010 but not part of the completed schedule assessment for provider payments were: meningococcal C vaccine (Men C); 7vPCV; and rotavirus vaccine. Varicella vaccine was also not included for coverage assessment but eligible providers received an information and SIP payment (up to October 2008)\* for reporting, as varicella vaccine is currently the only vaccine required for completion of the 18-month schedule point. While the ACIR records vaccines given only to Indigenous children in Queensland, Northern Territory, Western Australia and South

Australia (hepatitis A and 23vPPV and vaccines not included in the NIP such as BCG, reporting of these vaccines does not attract a GPII payment.<sup>1</sup>

Table 1 shows the Australian National Immunisation Program Schedule for 2010.

In 2004-05, the means test to qualify for the Maternity Immunisation Allowance<sup>†</sup> (MIA) was removed. This payment, of \$233 per child in 2008, was intended to provide motivation both to complete immunisation and for parents to prompt their provider to notify any outstanding reports to the ACIR before the child reaches 24 months of age. In the 2008-09 budget, in addition to the changes mentioned above, it was announced that the MIA payment would be paid in 2 equal amounts of \$167, with eligibility for the 2nd payment assessed between 48 and 60 months of age. This came into effect in January 2009, through a change in the National Due and Overdue Rules for Childhood Immunisation for all children born from 1 January 2005 onwards. They now state that a child is due for their 48-month old vaccinations at 48 months and overdue at 49 months of age, instead of overdue at 60 months of age.

## Methods

### The Australian Childhood Immunisation Register

The ACIR was established on 1 January, 1996, by incorporating demographic data from Medicare

\* GPII Outcomes Payments will cease on 30 June 2013.

† The MIA ceased in 2012 and was replaced from 1 July 2012 by a new immunisation check for one year olds to supplement the existing focus on immunisation at two and five years of age. Eligibility for the Family Tax Benefit Part A supplement will require that children are assessed as fully immunised.

**Table 1: Australian National Immunisation Program Schedule for children in 2010<sup>29</sup>**

Age	Vaccine									
Birth	Hep B									
2 months	Hep B	DTPa	Hib	Polio				7vPCV		Rotavirus
4 months	Hep B	DTPa	Hib	Polio				7vPCV		Rotavirus
6 months	Hep B	DTPa	Hib <sup>‡</sup>	Polio				7vPCV		Rotavirus <sup>§</sup>
12 months			Hib		MMR		Hep A <sup>  </sup>			Men C
18 months						VZV	Hep A <sup>  ¶</sup>	23vPPV <sup>  </sup>		
24 months							Hep A <sup>¶</sup>	23vPPV <sup>¶</sup>		
60 months		DTPa		Polio	MMR					

‡ 3rd dose of Hib vaccine at 6 months is dependent on vaccine brand used in state or territory

§ 3rd dose of rotavirus vaccine at 6 months is dependent on vaccine brand used in state or territory

|| Aboriginal and Torres Strait Islander children in Western Australia and the Northern Territory

¶ Aboriginal and Torres Strait Islander children in Queensland and South Australia

on all enrolled children under the age of 7 years.<sup>5</sup> Participation in the ACIR is opt-out hence it constitutes a nearly complete population register, as approximately 99% of children are registered with Medicare by 12 months of age.<sup>5</sup> Children not enrolled with Medicare can also be added to the ACIR via a supplementary number. Since 2001, immunisations given overseas may be recorded if a provider endorses their validity. Data are transferred to the ACIR when a recognised immunisation provider supplies details of an eligible immunisation either through the internet using the Medicare Australia website or by submitting paper encounter forms which are scanned at a central location. The existence of medical contraindications and conscientious objection to immunisation we are also recorded on the ACIR. All vaccination records for a child remain on the register indefinitely, but no new immunisation encounter records are added after the 7th birthday.

Immunisations recorded on the Register must be administered in accordance with the guidelines issued by the National Health and Medical Research Council as stated in *The Australian Immunisation Handbook*.<sup>18</sup> Notifications falling outside these guidelines or duplicate notifications prompt an enquiry with the provider and, if their validity cannot be established, they are rejected.

### Measuring immunisation coverage using the Australian Childhood Immunisation Register

The cohort method has been used for calculating coverage at the population level (national and state/territory)<sup>19</sup> since the ACIR's inception. Cohort immunisation status is assessed at 12 months of age (for vaccines due at 6 months), 24 months of age (for vaccines due at 12 months), and 60 months of age (for vaccines due at 48 months). A minimum 3-month lag period is allowed for late notification of immunisations to the Register, but only immunisations given on or before a child's 1st, 2nd or 5th respective birthdays are considered.<sup>19</sup> If a child's records indicate receipt of the last dose of a vaccine that requires more than 1 dose to complete the series, it is assumed that earlier vaccinations in the sequence have been given. This assumption has been shown to be valid.<sup>7,8</sup>

Three-month birth cohorts are used for time trend analyses, while 12-month wide cohorts are used for other analyses in this report such as for small area coverage analysis and mapping of coverage estimates. A minimum 3-month lag is allowed for late notifications. These cohorts are children born between 1 January and 31 December 2009 for the 12-month milestone age; children born between 1 January and 31 December 2008 for the 24-month milestone age; and children born between 1 January and 31 December 2005 for the 60-month milestone age.

The proportion of children designated as 'fully immunised' is 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. 'Fully immunised' at 12 months of age is defined as a child having a record on the ACIR of a 3rd dose of a diphtheria (D), tetanus (T), and acellular pertussis containing (P) vaccine (DTPa), a 3rd dose of polio vaccine, a 2nd or 3rd dose of a PRP-OMP containing (Hib) vaccine or a 3rd dose of any other Hib vaccine, and a 2nd or 3rd dose of a Comvax hepatitis B vaccine or a 3rd dose of dose of any other hepatitis B vaccine. 'Fully immunised' at 24 months of age is defined as a child having a record on the ACIR of a 3rd or 4th dose of a DTPa vaccine, a 3rd dose of polio vaccine, a 3rd or 4th dose of a PRP-OMP containing Hib vaccine or a 4th dose of any other Hib vaccine, a 3rd or 4th dose of Comvax hepatitis B vaccine or a 4th dose of any other hepatitis B vaccine, and a 1st dose of a measles, mumps and rubella-containing (MMR) vaccine. 'Fully immunised' at 60 months of age is defined as a child having a record on the ACIR of a 4th or 5th dose of a DTPa vaccine, a 4th dose of polio vaccine, and 2nd dose of a measles, mumps and rubella-containing (MMR) vaccine.

Immunisation coverage estimates were also calculated for individual NIP vaccines, including the 6 NIP vaccines not routinely reported in *Communicable Diseases Intelligence* (CDI). They were: a 3rd dose of 7vPCV and 2nd or 3rd dose of rotavirus vaccine by 12 months of age; a 1st dose of varicella vaccine and a 1st dose of meningococcal C vaccine by 24 months of age; a 2nd dose of hepatitis A vaccine in Indigenous children by 30 or 36 months of age; and a dose of 23vPPV vaccine in Indigenous children by 36 months of age.

Changes to immunisation policy and changes to the 'fully immunised' coverage algorithms have had an impact on vaccination coverage presented in this report. From the September 2009 coverage assessment date onwards, changes were made in the coverage calculation algorithms that tightened the rules regarding receipt of Hib and hepatitis B vaccines for children aged 12 months of age to lead to more accurate measures of coverage in Australia for these two vaccines. Prior to September 2009, if a child had a record on the ACIR of a 2nd or 3rd dose of any child Hib vaccine then they were considered 'fully vaccinated' for this vaccine. From September 2009, a child needed a record on the ACIR of a 3rd dose of any child Hib vaccine or a 2nd dose of either PedvaxHIB or Comvax to be assessed as 'fully vaccinated' for this vaccine. Prior to September 2009, if a child had a record on the ACIR of a 2nd or 3rd dose of any child hepatitis B vaccine then they were considered

'fully vaccinated' for this vaccine. From September 2009, a child needed a record on the ACIR of a 3rd dose of any child hepatitis B vaccine or a 2nd dose of either Engerix B (paediatric), Comvax, or HBVAX II (paediatric) to be assessed as 'fully vaccinated' for this vaccine. In October 2009, a recommendation was made by the Australian Technical Advisory Group on Immunisation that the 4th dose of DTPa containing vaccine can be given from 42 months of age instead of the previously recommended 48 months of age. In March 2009, another recommendation was made by the Australian Technical Advisory Group on Immunisation to parents and immunisation providers to consider bringing the first dose of DTPa forward to 6 weeks of age to provide earlier protection against pertussis infection. In January 2009, changes were made to the overdue rules so that children were classified as overdue for pre-school boosters at 49 months instead of the previous 60 months of age. This applied to parental and provider incentive payments. In December 2007, the coverage algorithm for immunisations due at 48 months of age was changed to assess children at 60 months, not 72 months of age.

### Timeliness

Age-appropriate immunisation was defined as receipt of a scheduled vaccine dose within 30 days of the recommended age. For example, a child who received the 1st dose of DTPa (due at 60 days of age) when he or she was more than 90 days of age was classified as not age-appropriately immunised (i.e. late for the dose). For descriptive purposes, we categorised the outcome measure for each dose as either vaccine dose 'no delay' (age-appropriately immunised), 'delay of between 1 to 6 months', or 'delay greater than 6 months'. Doses received 'too early' (greater than 30 days prior to when it was due), and doses never administered or recorded were excluded. Timeliness is measured in 12-month birth cohorts. Children included in the timeliness analysis were assessed at 1-2 years after doses were due, to allow time for late vaccinations to be recorded. Therefore, cohorts assessed for timeliness are not the same as those assessed for coverage milestones. The interval between doses was not evaluated. Timeliness of different vaccines and doses was also compared by plotting the cumulative percentage receiving each vaccine dose by age, with the proportion ever immunised set as 100%.

### Remoteness status

The area of residence of children was defined as accessible or remote using the Accessibility/Remoteness Index of Australia (ARIA), which was developed by the then Department of Health and Aged Care, and proposed as the national standard measure of remoteness for inclusion in the Australian Bureau

of Statistics (ABS) 2001 census.<sup>20</sup> For the timeliness analysis, we defined the two ARIA categories with most restricted access to services as 'remote' (approximately 2.6% of the Australian population) and all other areas as 'accessible'.

### Indigenous status

Indigenous status on the ACIR is recorded as 'Indigenous', 'non-Indigenous' or 'unknown', as reported by the child's carer to Medicare, or by the immunisation provider to the ACIR. For this report we considered two categories of children: 'Indigenous' and 'non-Indigenous', children with unknown Indigenous status were presumed to be 'non-Indigenous'. Coverage estimate time trends are presented from 2004 only, due to poor rates of reporting Indigenous status prior to then.<sup>21</sup>

### Small area coverage

Coverage was calculated for ABS-defined Statistical Subdivisions (SSD), chosen because each is small enough to show differences within jurisdictions but not too small to render maps unreadable.<sup>22</sup> Maps were created using version 10 of the MapInfo mapping software and the ABS Census Boundary Information.<sup>23</sup> As postcode is the only geographical indicator available from the ACIR, the ABS Postal Area to Statistical Local Area (SLA) Concordance 2006 was used to match ACIR postcodes to SSDs, in order to create a SSD field for each child in the relevant study cohorts.<sup>24</sup>

### Conscientious objection / No vaccine recorded

A child must be registered with Medicare before the parent(s) can lodge a conscientious objection to immunisation. Parents can also object to immunisation but refuse to lodge any official objection to the ACIR. We used the percentage of children with no vaccines recorded on the ACIR as a proxy measure of the number of these children.<sup>16</sup> Some children with no vaccines recorded on the ACIR will be officially registered as conscientious objectors to vaccination and some will not be registered as such. Registered conscientious objectors are eligible for parent incentive payments even if they are unvaccinated. Proportions of conscientious objectors and children with no vaccines recorded by region were calculated from the cohort of children registered with Medicare, and born between 1 January 2003 and 31 December 2009. At the time of data extraction on 31 March 2011, they were between 12 and 72 months of age. We chose this cohort when calculating proportions so that children under the age of 12 months were not included, to allow sufficient time for registration of objection and exclude infants late for vaccination.

## Human papillomavirus vaccine coverage

The HPV vaccination program is listed on the NIP Schedule, funded under the Immunise Australia Program and delivered to girls through an ongoing school-based program usually in the first year of secondary school. From 2007 to 2009 there was a time-limited catch-up program delivered through schools, general practices and community immunisation services. Immunisation for HPV is achieved with a course of 3 doses of vaccine, over a 6 month period. Data on the National HPV Vaccination Program is provided by the National HPV Vaccination Program Register. The purpose of this legislated register is to monitor and evaluate the vaccination program and is operated by the Victorian Cytology Service. The World Health Organization (WHO) proposes using 15 years as the reference age for HPV vaccination coverage for the purposes of international comparison. Data on HPV coverage was obtained from the Immunise Australia website.<sup>25</sup>

## Coverage in the elderly

Influenza and pneumococcal (23vPPV) vaccination coverage estimates in the elderly were taken from the 2009 Adult Vaccination Survey.<sup>26</sup> This telephone survey forms part of the evaluations of two vaccine programs for older Australia. The first is the National Influenza Vaccination Program for Older Australians, which commenced in 1999; the second is the National Pneumococcal Vaccination Program for Older Australians which commenced on 1 January 2005. This was a survey of 10,231 Australians aged 18 years or older, conducted during November to December 2009. Participants in the survey were asked about their recent experience of influenza and pneumococcal vaccination, and about their medical history and socio-demographic status.

## Results

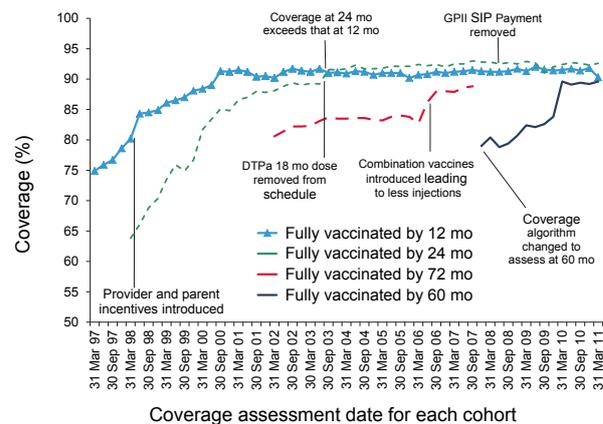
### Coverage estimates

#### Overall

Coverage estimates in 2010 for full-year birth cohorts at the 3 milestone ages of 12 months, 24 months and 60 months are provided in Tables 2, 3 and 4. Nationally, 'fully immunised' coverage and coverage for all individual vaccines for the 12-month and 24-month age groups exceed the 1993 Immunise Australia Program's target of 90%. Recorded national coverage for the 60-month age group is marginally below the target, at 89% for all vaccines, and lower in some jurisdictions.

Figure 1 shows time trends in 'fully immunised' childhood vaccination coverage in Australia, assessed at 12 months, 24 months, and at 60 months of age, for 3-month cohorts born from 1 January 1996 to 31 December 2009. The proportion 'fully immunised' at 12 months of age increased steadily from 75% for the 1st cohort in 1997 to 91.8% by 31 December 2010. At the 24-month milestone, 'fully immunised' coverage estimates also increased steadily from 64% for the 1st cohort to 92.3% by December 2010. 'Fully immunised' coverage estimates assessed at 72 months of age for vaccines due at 48 months were first reported in CDI in 2002, and increased steadily from 80.6% in early 2002 to 87.3% in late 2007, including a noticeable increase in June 2006, corresponding with the introduction of combination vaccines. However, from the beginning of 2008, when the assessment age was changed from 72 months to 60 months, 'fully immunised' coverage was substantially lower at 80.7% in December 2008, related to delayed immunisation. However, during 2009 and 2010, coverage for this age group rose substantially.

**Figure 1: Trends in 'fully immunised' vaccination coverage, Australia, 1997 to 2010, by age cohort**



Coverage calculated at 60 months was unchanged during the latter half of 2010 at 89%.

Coverage estimates for the 24-month age group increased substantially and suddenly in September 2003 to 91.6%, following the removal from the immunisation schedule of the 4th dose of DTPa (due at 18 months of age) from this quarter onwards. Coverage estimates for the 12-month age group have remained steady over the past 10 years, fluctuating around the 91% level.

There is a clear trend of increasing vaccination coverage over time for all age groups assessed, with the 2 youngest age cohorts having the highest coverage.

**Table 2: Percentage of children in 2010 immunised at 12 months of age, by vaccine and state or territory\***

Vaccine	Jurisdiction								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Total number of children	4,978	97,303	3,853	61,963	19,563	6,448	71,581	31,105	296,794
Diphtheria, tetanus, pertussis (%)	94.6	92.2	90.9	92.3	92.2	92.3	92.9	90.8	92.3
Poliomyelitis (%)	94.5	92.2	90.9	92.2	92.2	92.3	92.8	90.8	92.2
<i>Haemophilus influenzae</i> type b (%)	94.4	92.0	91.3	92.1	92.0	92.2	92.6	90.6	92.1
Hepatitis B (%)	93.7	91.8	90.7	91.9	91.7	92.1	92.3	90.3	91.8
Rotavirus (%)	88.0	86.4	81.6	83.2	84.6	86.1	83.7	85.6	84.7
7vPCV (%)	93.6	91.5	89.4	91.7	91.5	91.6	92.1	89.8	91.5
Fully immunised (%)	93.6	91.7	90.2	91.7	91.6	92.0	92.1	90.1	91.6
Fully immunised (incl rotavirus & 7vPCV) (%)	86.7	84.1	78.4	86.1	87.3	84.0	86.5	83.0	85.2

\* For the birth cohort born in 2009

**Table 3: Percentage of children in 2010 immunised at 24 months of age, by vaccine and state or territory\***

Vaccine	Jurisdiction								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Total number of children	4,923	98,729	3,711	63,062	19,779	6,609	72,248	31,499	300,560
Diphtheria, tetanus, pertussis (%)	96.0	94.6	95.1	94.5	94.5	95.3	95.4	93.4	94.7
Poliomyelitis (%)	95.9	94.6	95.0	94.4	94.5	95.3	95.4	93.3	94.6
<i>Haemophilus influenzae</i> type b (%)	95.6	94.8	94.0	94.2	94.2	95.3	95.1	93.2	94.6
Hepatitis B (%)	95.2	94.1	94.6	93.9	94.0	95.1	94.7	92.5	94.1
Measles, mumps, rubella (%)	94.8	93.8	95.0	93.9	93.8	94.9	94.6	92.5	93.9
Varicella (%)	87.5	82.1	84.9	86.4	81.9	81.7	82.7	79.4	83.0
MenC (%)	94.4	93.4	94.9	93.5	93.7	94.8	94.3	91.9	93.6
Fully immunised (%)	93.3	92.1	92.4	92.2	92.1	93.6	92.9	90.0	92.1
Fully immunised (incl varicella & MenC) (%)	85.6	80.0	82.5	84.8	80.2	80.2	80.9	77.2	81.1

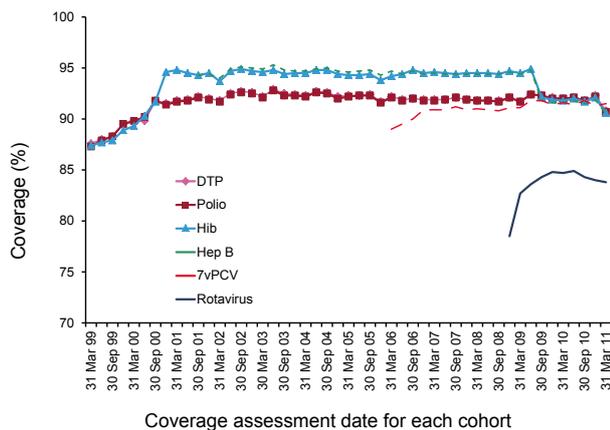
\* For the birth cohort born in 2008

**Table 4: Percentage of children in 2010 immunised at 60 months of age, by vaccine and state or territory\***

Vaccine	State or territory								Australia
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	
Total number of children	4,628	93,742	3,576	60,695	18,699	6,263	68,128	29,601	285,332
Diphtheria, tetanus, pertussis (%)	91.3	89.5	87.5	90.3	87.6	91.9	91.2	86.6	89.7
Poliomyelitis (%)	91.5	89.4	87.4	90.3	87.6	91.9	91.3	86.7	89.7
Measles, mumps, rubella (%)	91.1	89.3	87.1	90.2	87.4	92.0	91.1	86.5	89.6
Fully immunised (%)	90.7	88.9	86.6	89.7	87.0	91.5	90.7	85.9	89.1

\* For the birth cohort born in 2005

**Figure 2: Trends in vaccination coverage estimates for individual vaccines at 12 months of age (DTPa, polio, hepatitis B and Hib)\***

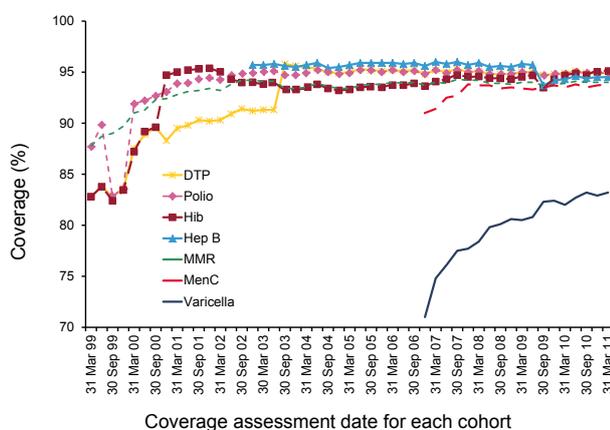


Source: Australian Childhood Immunisation Register.

By 3-month birth cohorts born between 1 January 1999 and 31 December 2009. Coverage assessment date was 12 months after the last birth date of each cohort.

\* 3rd dose of DTP and polio, 2nd or 3rd dose of Hib and Hep B

**Figure 3: Trends in vaccination coverage estimates for individual vaccines at 24 months of age (DTPa, polio, hepatitis B, Hib and MMR)\***



Source: Australian Childhood Immunisation Register.

By 3-month birth cohorts born between 1 January 1998 and 31 December 2008. Coverage assessment date was 24 months after the last birth date of each cohort.

\* 3rd or 4th dose of DTP, 3rd dose of polio, 3rd or 4th dose of Hib, 2nd or 3rd dose of Hep B, and 1 dose of MMR

### Individual vaccines

DTPa and polio coverage at 12 months of age remained relatively stable from the latter part of 2001 to 2010 (Figure 2).

Prior to the change in algorithm to measure coverage that occurred in the latter half of 2009, coverage for the Hib and hepatitis B vaccines at 12 months

**Table 5: Vaccination coverage estimates by age, vaccine and Indigenous status, 2010**

Vaccine	Milestone age	Indigenous	Non-Indigenous
DTPa	12 mths*	85.5	92.6
	24 mths†	94.1	94.7
	60 mths‡	85.7	89.9
Polio	12 mths*	85.5	92.5
	24 mths†	94.0	94.7
	60 mths‡	85.7	89.9
Hib	12 mths*	83.5	92.0
	24 mths†	94.5	94.8
	60 mths‡	N/A§	N/A§
Hep B	12 mths*	85.5	92.1
	24 mths†	96.9	95.4
	60 mths‡	N/A§	N/A§
MMR	12 mths*	N/A§	N/A§
	24 mths†	94.4	93.9
	60 mths‡	86.2	89.7
Varicella	12 mths*	N/A§	N/A§
	24 mths†	82.2	83.0
	60 mths‡	N/A§	N/A§
Meningococcal C	12 mths*	N/A§	N/A§
	24 mths†	93.9	93.5
	60 mths‡	N/A§	N/A§
7vPCV	12 mths*	85.2	91.8
	24 mths†	N/A§	N/A§
	60 mths‡	N/A§	N/A§
Rotavirus	12 mths*	71.7	85.1
	24 mths†	N/A§	N/A§
	60 mths‡	N/A§	N/A§

\* Birth cohort born 1 January 2009 – 31 December 2009

† Birth cohort born 1 January 2008 – 31 December 2008

‡ Birth cohort born 1 January 2005 – 31 December 2005

§ Not included in coverage estimates for that group

of age become similar to those for DTPa and polio in the last two cohorts of 2009 and all of 2010 (Figure 2). Coverage for 7vPCV rose steadily from below 90% in mid-2007 to be just below that for all other vaccines due at this age at around 92%, except for rotavirus vaccine. Rotavirus vaccine coverage rose steeply from late 2008 from below 70% to almost 85% in late 2010.

For most of the study period, at 24 months of age, hepatitis B coverage was higher than for all other vaccines, at just under 95%, due to the different coverage algorithm described above (Figure 3). Coverage was lowest for MMR and Hib, the only vaccines that have a 12-month dose used in

**Table 6: Percentage of children fully immunised at 12 months, 24 months and 60 months of age, by Indigenous status and state or territory, 2010**

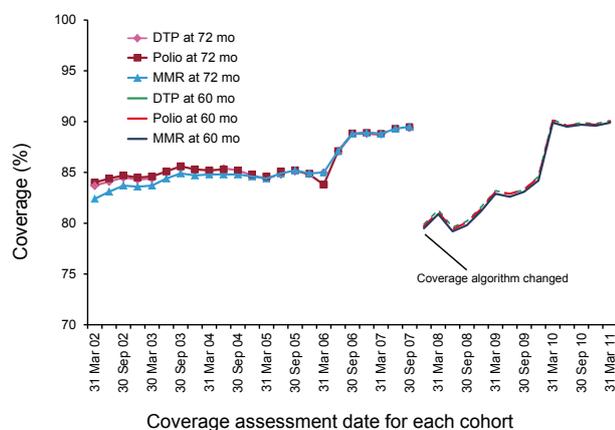
	States and Territories								Australia
	ACT	NSW	VIC	QLD	SA	WA	TAS	NT	
<b>12 months – fully immunised (%)*</b>									
Indigenous	87.1	87.2	84.6	85.9	79.3	80.6	89.1	87.7	85.4
Non-Indigenous	94.2	92.0	92.5	92.4	92.2	90.9	92.4	92.6	92.1
<b>12 months – fully immunised (including rotavirus &amp; 7vPCV) (%)</b>									
Indigenous	73.1	76.2	77.4	76.0	74.8	69.2	79.4	68.2	74.3
Non-Indigenous	87.0	84.5	86.7	87.0	87.8	83.9	84.4	86.0	85.8
<b>24 months – fully immunised (%)†</b>									
Indigenous	97.9	91.5	92.5	92.6	90.0	87.3	93.1	93.5	91.6
Non-Indigenous	93.8	92.4	93.3	92.5	92.5	90.6	93.8	92.2	92.5
<b>24 months – fully immunised (including varicella &amp; MenC) (%)</b>									
Indigenous	89.3	78.4	76.6	82.4	77.0	72.7	77.1	84.7	79.5
Non-Indigenous	85.9	80.2	81.2	85.2	80.6	77.7	80.5	81.5	81.4
<b>60 months – fully immunised (%)‡</b>									
Indigenous	86.6	84.4	86.4	86.9	79.2	80.8	90.0	89.4	85.3
Non-Indigenous	90.7	89.1	90.8	89.9	87.3	86.2	91.6	84.6	89.3

\* 'Fully immunised' - 3 doses of a diphtheria (D), tetanus (T) and pertussis-containing (P) vaccine, 3 doses of polio vaccine, 2 or 3 doses of PRP-OMP-containing *Haemophilus influenzae* type b (Hib) vaccine or 3 doses of any other Hib vaccine, and 2 or 3 doses of Comvax hepatitis B vaccine or 3 doses of all other hepatitis B vaccines.

† 'Fully immunised' - 3 or 4 doses of a DTPa-containing vaccine, 3 doses of polio vaccine, 3 or 4 doses of PRP-OMP-containing Hib vaccine or 4 doses of any other Hib vaccine, 3 or 4 doses of Comvax hepatitis B vaccine or 4 doses of all other hepatitis B vaccines, and 1 dose of a measles, mumps and rubella-containing (MMR) vaccine.

‡ 'Fully immunised' - 4 or 5 doses of a DTPa-containing vaccine, 4 doses of polio vaccine, and 2 doses of an MMR-containing vaccine.

**Figure 4: Trends in vaccination coverage estimates for individual vaccines (DTPa, polio, and MMR)\* at 60 months (72 months prior to December 2007)**



Source: Australian Childhood Immunisation Register.

By 3-month birth cohorts born between 1 January 1996 and 31 December 2005. Coverage assessment date was 72 months after the last birth date of each cohort up to December 2007 and then 60 months after the last birth date of each cohort.

\* 4th dose of DTP and polio, 2nd dose of MMR.

calculations. The overall coverage estimates for 24-month olds are approaching 95% for all vaccines except varicella.

There was a marked increase in coverage for individual vaccines at 60 months of age following the change in the due/overdue rules in January 2009, with coverage increasing to levels similar to when coverage was assessed at 72 months of age (Figure 4).

#### Coverage estimates for Indigenous children

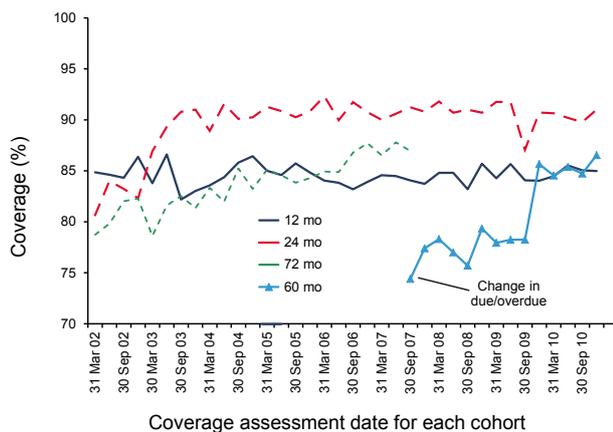
Immunisation coverage is lower for Indigenous children than non-Indigenous at the 12-month, 24-month and 60-month age milestones for most vaccines, with the difference being greatest at 12 months of age (Table 5). The difference in coverage at 12 months of age has been relatively consistent for the past 7 years. The coverage differential between Indigenous and non-Indigenous children for individual vaccines varies, with coverage at 24 months of

age for most vaccines being almost identical for both groups and greater among Indigenous children for hepatitis B, MMR and meningococcal C vaccines.

The proportion of children 'fully immunised' by 24 months of age has consistently remained higher than at 12 months and 60 months of age (Figure 5). For non-Indigenous children, coverage at 60 months of age increased following the change in due/overdue rules. Coverage in 2010 was the same at 12 months and 60 months of age.

At age 12 months, the overall proportion of Indigenous children fully vaccinated was 85.4%, compared with 92.1% for non-Indigenous children (Table 6). Although coverage was lower among Indigenous children in all jurisdictions, the extent of the difference varied, reaching a 14 percentage point differential in South Australia and a 10 percentage point differential in Western Australia. However, by age 24 months, the coverage disparity between Indigenous and non-Indigenous children had

**Figure 5: Trends in 'fully immunised' vaccination coverage for Indigenous children in Australia, 2004 to 2010, by age cohorts**



greatly reduced nationally to be less than 1 percentage point lower for Indigenous children, ranging from 4 percentage points higher in the Australian Capital Territory to 3.3 percentage points lower in Western Australia.

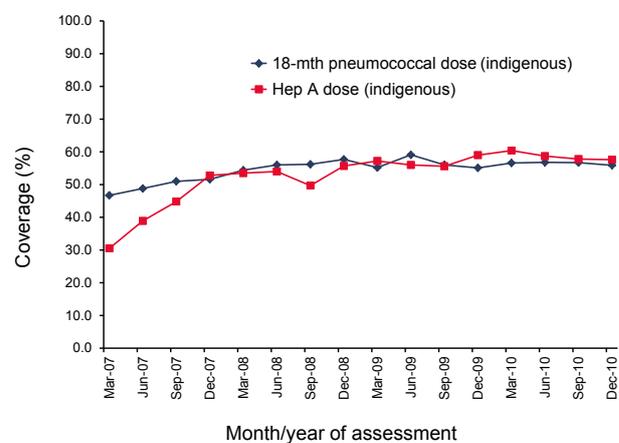
At 60 months of age, the proportion of Indigenous children recorded as being 'fully vaccinated' was lower than that at 24 months of age. At the national level, the coverage for Indigenous and non-Indigenous children was 85.3% and 89.3%, respectively. There was dramatic variation between individual jurisdictions, ranging from coverage 8.1% lower in Indigenous children in South Australia to 4.8% higher in the Northern Territory, compared to non-Indigenous children (Table 6) in 2010.

## Coverage for National Immunisation Program vaccines not routinely reported elsewhere

### 7vPCV and Rotavirus

7vPCV was first added to the NIP in January 2005. Since coverage was first calculated for this vaccine in early 2006, it has remained high, with a slight increase from 89% to 91.5% (Figure 2). Coverage is greater than the 1993 Immunise Australia Program target of 90% in all jurisdictions except for Western Australia and Tasmania where it approaches 90% (Table 2).

**Figure 6: Trends in coverage for hepatitis A\* and pneumococcal polysaccharide (23vPPV) vaccines for Indigenous children, 2007 to 2010**



\* Two doses assessed at 30 months for WA and NT. 2 doses assessed at 36 months for QLD and SA.

Rotavirus vaccine was added to the NIP in July 2007, thus coverage for 2 or 3 doses (depending on vaccine) at 12 months of age could be calculated only from the December 2008 quarter. Rotavirus coverage was lower nationally (Figure 2), and had greater variation between jurisdictions compared to other vaccines given at 2, 4 and 6 months, which may be due to the strict upper age limits for this vaccine. Reported coverage for 2 or 3 doses (Rotarix® versus Rotateq®) of rotavirus vaccine at 12 months of age varied from 83.2% in Queensland (Rotateq®) to 86.4% and 88% in New South Wales and the Australian Capital Territory (both Rotarix®) respectively (Table 2).

### Meningococcal C and Varicella

Meningococcal C vaccine was added to the NIP in January 2003. Since coverage was first calculated for this vaccine in early 2006, it has remained at high levels, with an increase over 2 years from 88% to almost 94% (Figure 3). There was little variation by

jurisdiction, with all jurisdictions experiencing coverage levels greater than 91% and some, Victoria and Western Australia, closely approaching 95% (Table 3).

Varicella vaccine was added to the NIP in November 2005. Reported coverage for this vaccine has consistently been 10–15 percentage points lower than that for all the other vaccines assessed at 24-month milestone, being 83% for the latest assessment (Figure 3). This is probably partly due to the shorter time varicella has been on the NIP and the age of administration (18 months). The 18-month schedule point was historically associated with lower coverage when there was an 18-month pertussis booster prior to 2003, there was a gap when no vaccine was administered at 18 months over 2 years and only one vaccine is given. Reported varicella vaccine coverage

**Table 7: Vaccination coverage\* for hepatitis A (Indigenous only) and 23vPPV (Indigenous only) by state/territory**

State/territory	Vaccine type	
	Hep A†	23vPPV‡
NT	81.5 (84.2)	69.6
QLD	53.2 (61.4)	55.0
SA	31.5 (49.7)	39.7
WA	60.1 (64.7)	57.1
AUST	57.6 (65.6)	56.7‡

\* For the last 3-month cohort assessable in 2010

† Indigenous only: 2 doses by 30 months of age for WA and NT (1 dose by 18 months of age), 2 doses by 36 months of age for QLD and SA (1 dose by 24 months of age)

‡ Indigenous only: 1 dose by 36 months of age for Northern Territory, Queensland, South Australia and Western Australia only

also shows considerable variation by jurisdiction from 79.4% in Tasmania to 87.5% in the Australian Capital Territory (Table 3). Data are also available from the ACIR on the numbers of reports from GPs stating that children born since May 2004 have

natural immunity to varicella and do not require varicella vaccination. Reports of natural immunity to varicella total greater than 20,000 since May 2004 (not shown), corresponding to approximately 1.1% of the cohort. It is likely that there is underreporting of presumed natural immunity by GPs but this is unlikely to fully account for lower varicella coverage.

### Hepatitis A and 23vPPV

Hepatitis A vaccine was available in Australia prior to the development of the ACIR in 1996 and has been included on the NIP for Indigenous children in the Northern Territory, South Australia, Western Australia, and in Queensland since November 2005, but was used earlier than this in North Queensland. Since March 2007, coverage of 2 doses of hepatitis A vaccine by 30 months of age in Western Australia and the Northern Territory and 36 months of age in Queensland and South Australia for Indigenous children has increased from below 20% to 58% in December 2010 (Figure 6). An additional 8% of children had received 1 dose of hepatitis A vaccine by 18 or 24 months of age, increasing national coverage for at least one dose of hepatitis A vaccine to 66% in Indigenous children (Table 7). There is a variation in reported hepatitis A vaccine coverage by jurisdiction, from a low of 31.5% in South Australia to a high of 81.5% in the Northern Territory (Table 7).

The 23vPPV has been recommended for Indigenous children in the same 4 jurisdictions (the Northern Territory, South Australia, Western Australia, and Queensland) as a booster at 18–24 months of age since 2001; coverage has gradually increased from 47% in December 2006 to 56% in December 2010 (Figure 6). There is a large variation in 23vPPV coverage by jurisdiction from a low of 39.7% in South Australia to a high of 69.6% in the Northern Territory (Table 7).

**Table 8: Vaccination delay, by Indigenous and remoteness status for the cohort of children born in 2008, Australia**

Vaccine dose	Indigenous status	Remoteness	1–6 mths delay %	> 6 mths delay %
DTPa3	Indigenous	Accessible	30	8
		Remote	34	7
	Non-Indigenous	Accessible	17	2
		Remote	16	2
MMR1	Indigenous	Accessible	33	5
		Remote	33	4
	Non-Indigenous	Accessible	25	2
		Remote	24	2

**Table 9: Vaccination coverage for dose 3 of HPV vaccine for girls aged 15 years, 2009**

State/territory	Vaccine type
	HPV
NSW	73.0
Vic	76.1
Qld	71.1
WA	64.7
SA	72.4
Tas	63.7
ACT	79.6
NT	76.1
Australia	70.8

Source: Human papillomavirus vaccination coverage data Australian Government. Department of Health and Ageing, April 2011, Available from: <http://www.immunise.health.gov.au/internet/immunise/publishing.nsf/Content/immunise-hpv>

Includes only eligible consumers and vaccinations given as part of the National HPV Vaccination Program

Includes valid doses and too close doses for Clinically Complete Consumers

Population is Estimated Resident Population provided by the Australian Bureau of Statistics - Cat 3101.0, Australian Demographic Statistics, Tables 51 to 59: Estimated Resident Population By Single year of Age by State and Territory, published June 2010 for 2010.

Age is age as at date of Estimated Resident Population estimate

Coverage is calculated as doses administered and reported to the National HPV Program Register (NHPVPR) / estimated resident population expressed as a percentage

Excludes consumers who do not wish their details to be recorded on the HPV Register.

### Timeliness of immunisation

Timeliness has been examined for vaccines requiring both multiple doses (DTPa, 7vPCV and MMR) and a single dose (Men C) at 12 and 24 months of age.

Since 2004, the proportion of children with timely receipt of the 3rd dose of DTP vaccine has remained at 88% (not shown). Across the 5-year period, 2004–2008, timely receipt of 1 dose of MMR rose only 3 percentage points, although estimated coverage by 24 months of age remained stable at almost 94% (not shown).

As demonstrated in previous studies, the proportion with vaccination delay increased with older age (Figure 7). The greatest proportion with any delay was seen with the second dose of MMR vaccine with 65% of doses given late and almost 24% given more than 6 months late. This is a considerable improvement over the 2009 report where the corresponding figures were 80% and 35%.

**Table 10: Estimated seasonal influenza and pneumococcal vaccination status, persons aged 65 year or older, 2009**

State/territory	Vaccine type	
	Influenza †	Pneumococcal (23vPPV) ‡
NSW	72.7	53.5
Vic	75.0	55.5
Qld	74.6	54.6
WA	72.9	51.8
SA	81.3	57.6
Tas	77.5	55.4
ACT	78.0	53.3
NT	69.3*	47.8*
Australia	74.6	54.4

Source: Australian Institute of Health and Welfare. 2009 Adult Vaccination Survey – Summary results. Canberra, March 2011. <http://www.aihw.gov.au/publication-detail/?id=10737418409&tab=2> Published with permission from the Australian Institute of Health and Welfare.

\* Estimate has 25% or greater relative standard error

† Vaccine received in the past 12 months

‡ Vaccine received in the past 5 years

For the 3rd dose of DTPa, there was greater delay for Indigenous children than non-Indigenous children, with a 21% differential of on-time vaccination at 6 months of age (Figure 8). The same pattern was found for timeliness of the 1st dose of MMR, but with a smaller differential of 11% (Figure 9). Although Indigenous children had only slightly lower coverage than non-Indigenous children by 24 months of age, they were more likely to have delayed vaccination.

Vaccination was delayed by more than one month for 30–34% of Indigenous children and 16–25% of non-Indigenous children (Table 8). The proportion with long delays (i.e. greater than 6 months) was 2–4 times higher in Indigenous children than in non-Indigenous children, with no great differences between accessible and remote areas or vaccines. Delays of 1–6 months were also more frequent for Indigenous children, although less marked, especially for the first dose of MMR. The proportion with short delays was greater among Indigenous children residing in remote areas than in accessible areas for the 3rd dose of DTP vaccine (34% versus 30%), but not for the 1st dose of MMR.

Vaccination delay for Indigenous children by jurisdiction was measured for 7vPCV, with greater delays in Western Australia (47.4%) and South Australia (42.6%) (Figure 10). The proportion of South Australian Indigenous children with long delays in receipt of the 3rd dose of 7vPCV vaccine decreased

from the previous report in 2009 (from 7.7% to 5.8%) but increased in Indigenous children from the Northern Territory (5.2% to 6.9%). There were no important differences in vaccination delay for non-Indigenous children by jurisdiction (not shown).

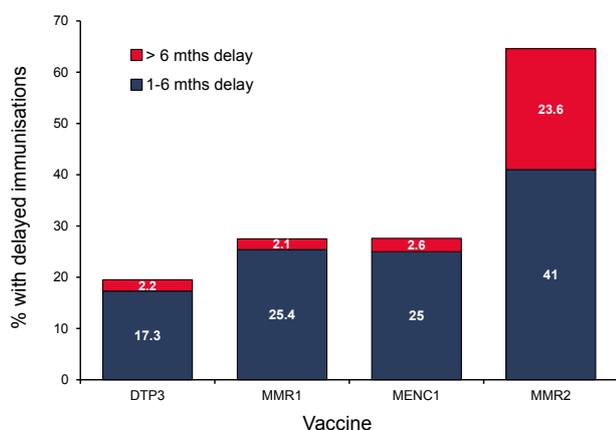
In contrast to younger ages, analysis of timeliness of immunisation for a vaccines at 48 months of age, the 2nd dose of MMR, showed a small difference in delay in receiving this vaccine for non-Indigenous children and Indigenous children, with only a 3.0% differential at 4 years and 3 months of age (Figure 11). However, timeliness for both groups was improved from the previous report in 2009.

In response to the current pertussis epidemic and to provide early protection to young infants, it was recommended by the Australian Technical Advisory Group on Immunisation (ATAGI) in March 2009 and promoted in New South Wales and Tasmania that immunisation providers give the first dose of DTPa vaccine at 6 weeks of age instead of 8 weeks of age. Prior to this very few children received the vaccine dose at less than 8 weeks of age but for New South Wales and Tasmania the percentage rose over the 2 years with more than 60% of children receiving the dose prior to 8 weeks of age in December 2010 (Figure 12). In late 2010 this percentage also began to increase in other jurisdictions but not to the same extent as in New South Wales and Tasmania.

**Small area coverage**

Immunisation coverage in Australia in 2010 varies substantially within jurisdictions, with some areas substantially below the national averages, potentially

**Figure 7: Vaccination delay - cohorts born in 2008 (DTPa3, MMR1, MENC1) and 2004 (MMR2)**



DTP3 = 3rd dose of a diphtheria (D), tetanus (T) and pertussis-containing (P) vaccine

MMR1 = 1st dose of a measles, mumps and rubella vaccine

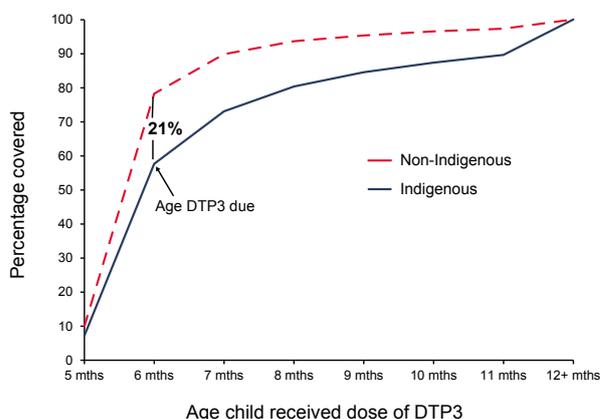
MENC1 = 1st dose of a meningococcal C vaccine

MMR2 = 2nd dose of a measles, mumps and rubella vaccine

putting them at risk of outbreaks (Figures 13-15). In particular, there are many areas with coverage at 60 months of age below 85% (Figure 15).

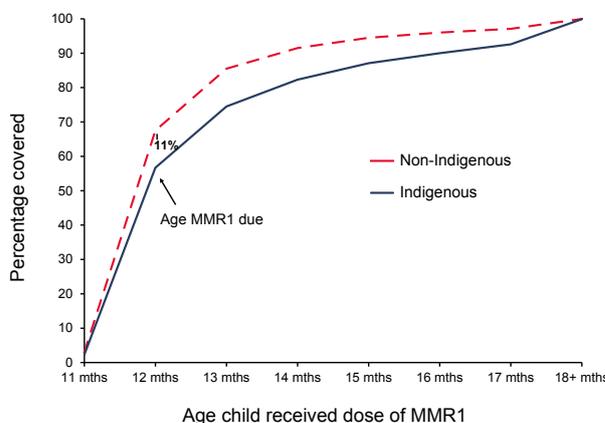
The proportion of children whose parents recorded as conscientious objectors and with no vaccines recorded are presented by SSD in Figures 16 and 17, respectively. No vaccines recorded may represent either non-immunisation (parents refusing any vaccines) or, and probably much less commonly, non-reporting by a provider. The percentage of children with no vaccines recorded nationally (3.0%) is greater than those recorded as conscientious objectors (1.7%). The map of the proportion of conscientious objectors to immunisation shows pockets of high levels of objection within jurisdictions in 2009, particularly in coastal areas of south

**Figure 8: Timeliness of the 3rd dose of DTP vaccine (DTPa3) by Indigenous status – cohort born in 2008\***



\* Percentage covered = number of children who received vaccine dose at particular ages/the total number of children who received the vaccine dose

**Figure 9: Timeliness of the 1st dose of MMR vaccine (MMR1) by Indigenous status – cohort born in 2008\***



\* Percentage covered = number of children who received vaccine dose at particular ages/the total number of children who received the vaccine dose

east Queensland, northern New South Wales, the Mount Lofty Ranges region in South Australia and south west Western Australia, which also appear with low coverage in Figures 13-16.

The map of the proportion of children with no vaccines recorded (Figure 17) shows some additional areas not evident from, but usually adjacent to, maps of official conscientious objection. Children with no vaccines recorded and children who have parents who register as a conscientious objector are not mutually exclusive groups. Only 30% of children with no vaccines recorded were registered conscientious objectors, whilst 45% of conscientious objectors have vaccines recorded on the ACIR (not shown). Areas with low or normal levels of conscientious objection and/or low levels of no vaccines recorded but low coverage may reflect access issues rather than issues of ideology.

### Provider type

GPs administer the large majority of immunisations in Australia; the proportion given by GPs has increased over the past 11 years by almost 5% (not shown) (Figure 18). Local government clinics also administer a substantial proportion of immunisations, especially in some jurisdictions. The only other category of provider administering major numbers of immunisations nationally is community health centres. Regional differences are marked, with immunisations almost entirely administered by GPs in some jurisdictions (New South Wales, Queensland, South Australia, Tasmania and Western Australia), while in others a majority are given by local government (Victoria) and community health clinics (the Northern Territory).

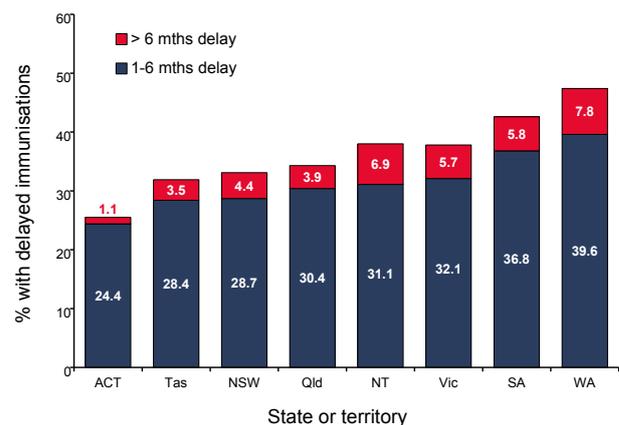
### Human papillomavirus vaccine coverage

Vaccination coverage for dose 3 of the HPV vaccine for girls aged 15 years in 2009 is shown in Table 9. For Australia, almost 71% of girls completed a full course of the vaccine. Coverage varied by jurisdiction from a low of 63.7% in Tasmania to a high of 79.6% in the Australian Capital Territory. Coverage in all age groups was higher for earlier doses, as high as 84% for the first dose in girls aged 14 to 15 (Figure 19). Coverage was higher in the younger age groups than the older age groups with only 30% of girls aged 20-26 years and 38% of girls aged 18 to 19 years vaccinated for the third dose of HPV vaccine.

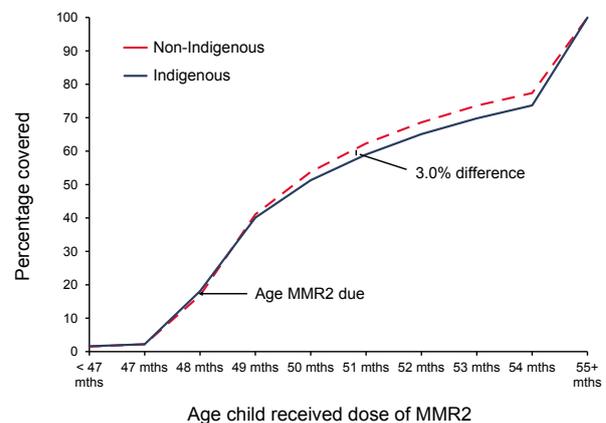
### Vaccines for the elderly (pneumococcal and influenza)

In 2009, influenza (in previous 12 months) and pneumococcal polysaccharide (23vPPV) (in previous 5 years) vaccine coverage in the elderly

**Figure 10: Vaccination delay for Indigenous children for the 3rd dose of 7vPCV by jurisdiction, cohort born in 2008**

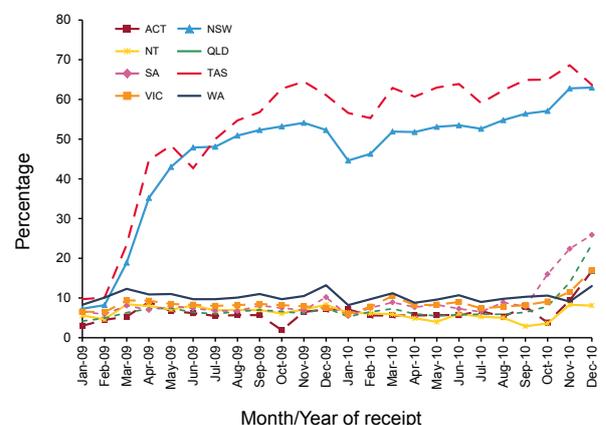


**Figure 11: Timeliness of the 2nd dose of MMR vaccine (MMR2) by Indigenous status – cohort born in 2004\***

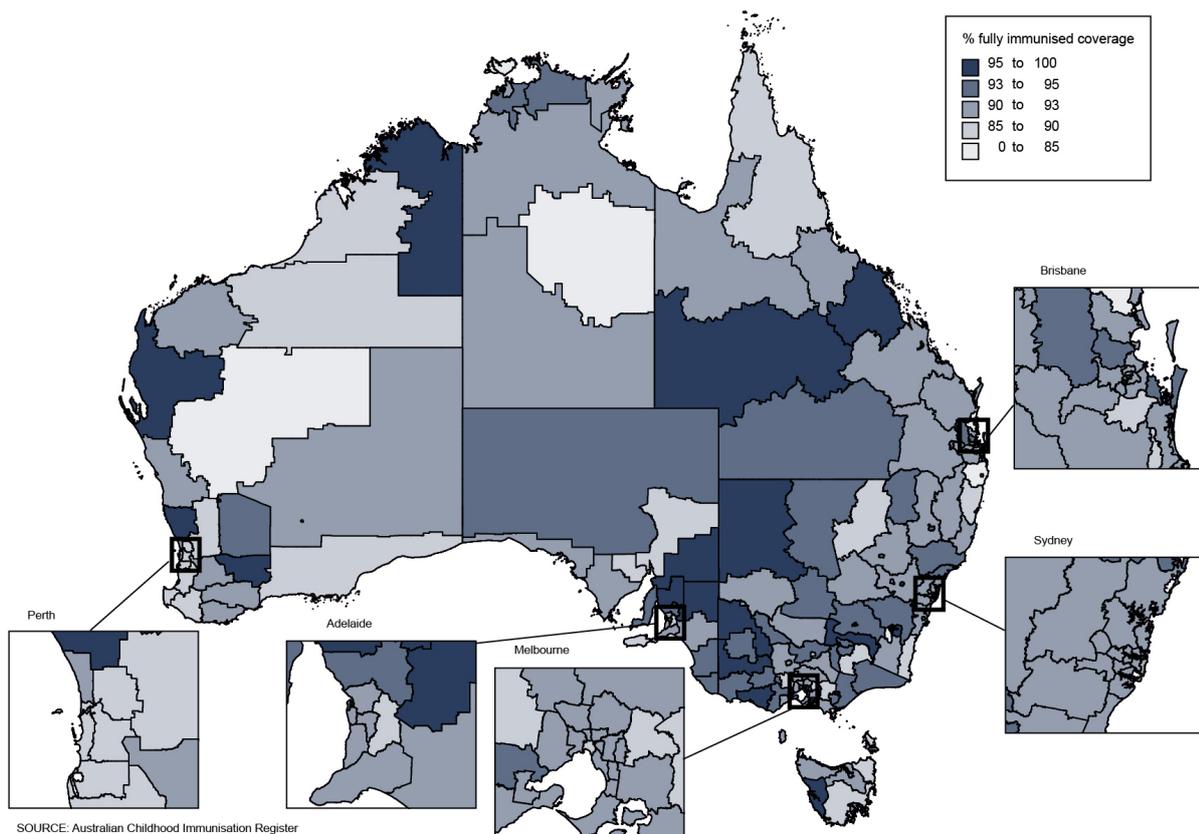


\* Percentage covered = number of children who received vaccine dose at particular ages/the total number of children who received the vaccine dose

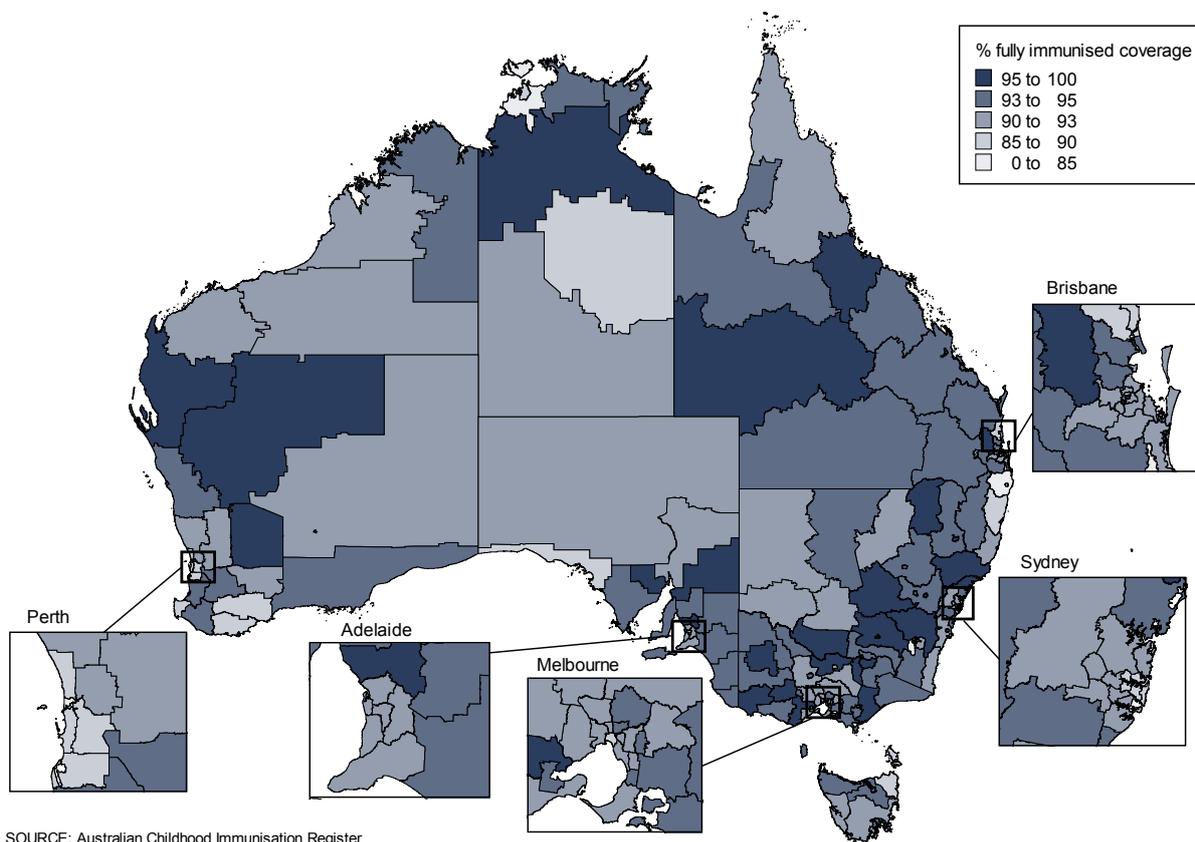
**Figure 12: The percentage of children who received their 1st dose of DTPa/Hexa vaccine at age 6 < 8 weeks, by jurisdiction and month of receipt, January 2009 – December 2010**



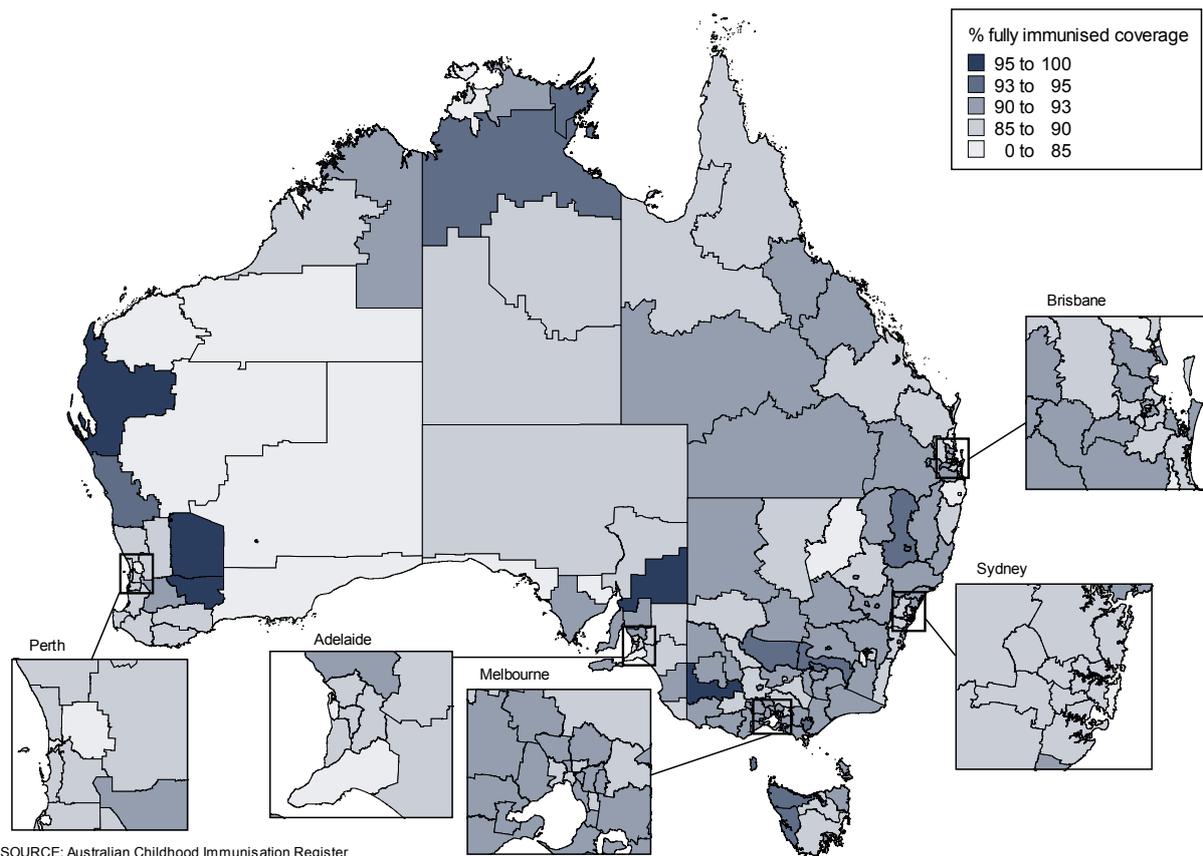
**Figure 13: 'Fully immunised' coverage at 12 months of age Australia, by Statistical Sub-Division, 2010**



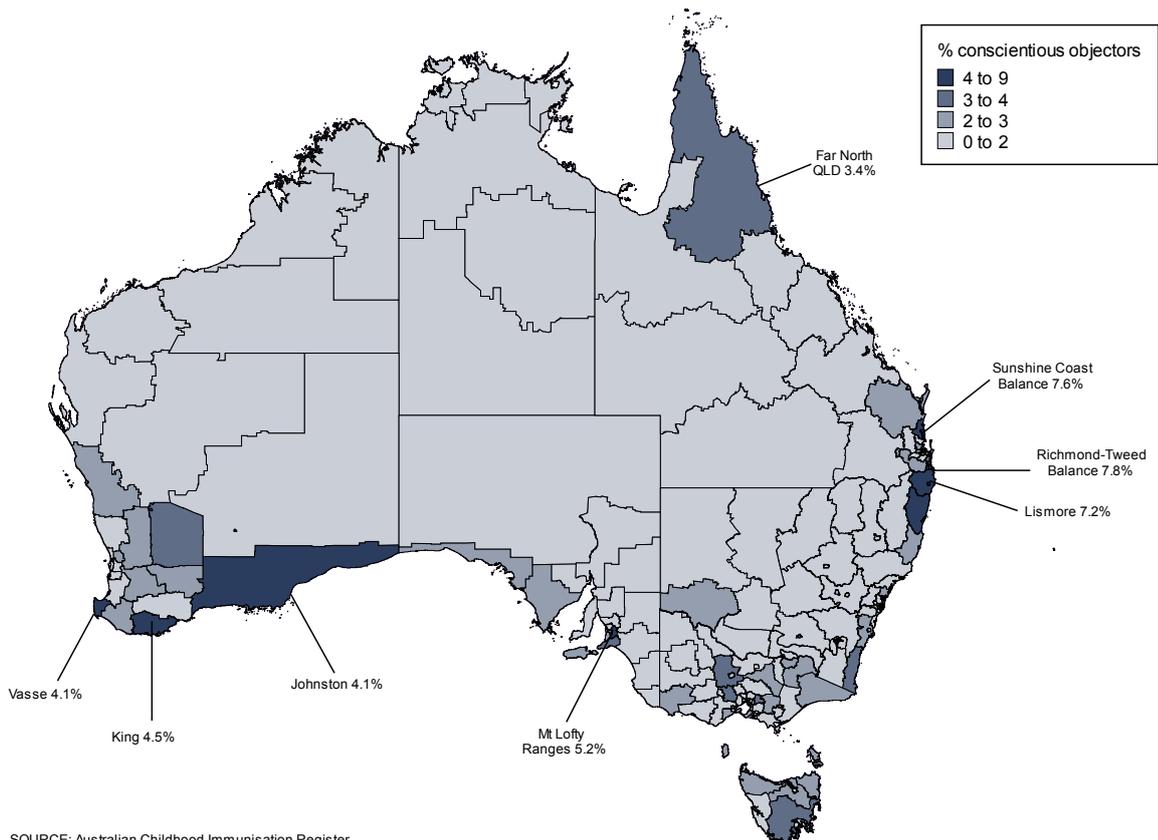
**Figure 14: 'Fully immunised' coverage at 24 months of age Australia, by Statistical Sub-Division, 2010**



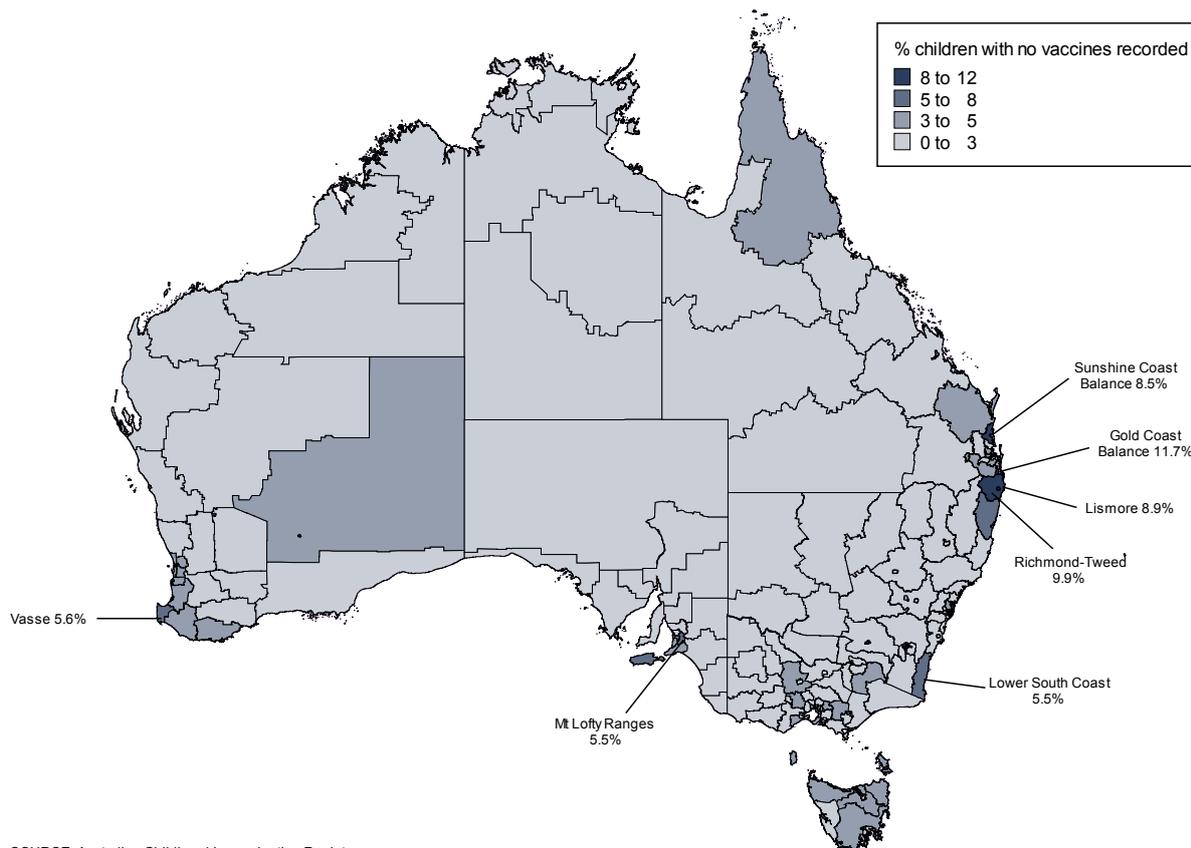
**Figure 15: 'Fully immunised' coverage at 5 years of age Australia, by Statistical Sub-Division, 2010**



**Figure 16: Proportion of official conscientious objectors to immunisation, Australia, 2010 (cohort born Jan 2004 – Dec 2009)**

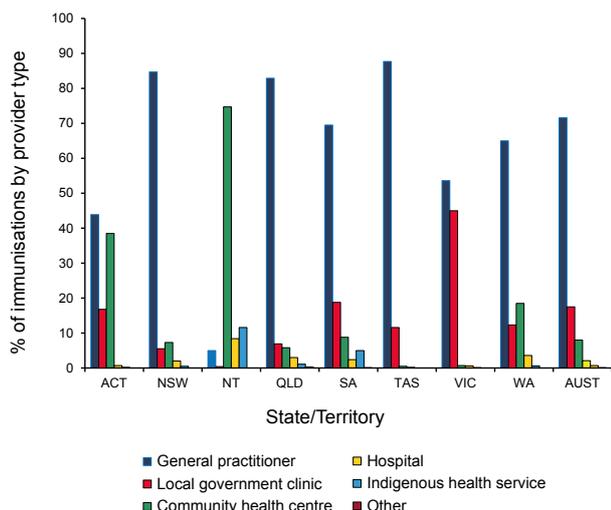


**Figure 17: Proportion of children with no vaccines recorded on the ACIR, Australia, 2010 (cohort born Jan 2004 – Dec 2009)**



SOURCE: Australian Childhood Immunisation Register

**Figure 18: Proportion of immunisations on the ACIR given by various provider types, by state or territory, 2010**



were highest in South Australia and Tasmania and lowest in the Northern Territory and Western Australia (Table 10).

### Discussion

These data show that 1993 Immunise Australia Program coverage targets (90%) have been reached for children both 12 and 24 months of age. However, this is not the case for children 60 months of age where coverage, whilst much improved, is below the target in some jurisdictions.

“Fully immunised” coverage at 24 months of age marginally exceeds that at 12 months of age, and this is likely related to the exclusion of varicella vaccine at 18 months from calculation of ‘fully vaccinated’, the absence of any other vaccines administered between those ages, and the impact of immunisation incentives. Coverage for vaccines due at 48 months of age improved considerably during 2009 and 2010 approaching 90% for all 4 cohorts in 2010. This increase is due to improved timeliness of vaccination, and is probably related to the change to the overdue rules in January 2009, where children became overdue for their pre-school boosters at 49 months of age instead of the previous 60 months.

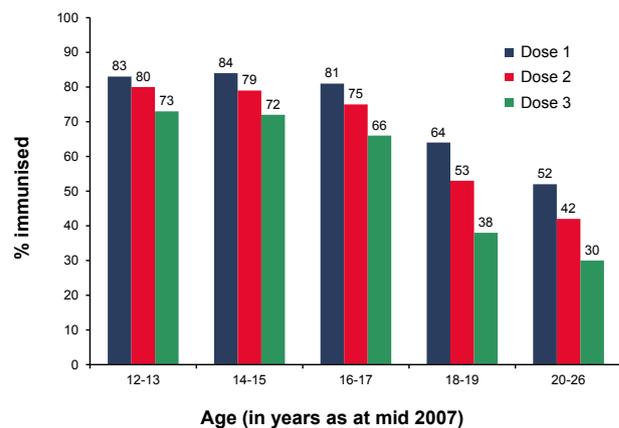
This change had an impact on eligibility for child care benefits for parents and outcome payments for providers. It was accompanied by a letter from Medicare Australia advising parents of the change, and the follow-up of overdue children by local health authorities. It is unlikely that the splitting of the Maternity Immunisation Allowance at that time could have had an impact in these data, as it applies only to children turning 48 months from 2011 onwards. Parents of older children would have received the full Maternity Immunisation Allowance payment at 24 months of age and were therefore not eligible for another payment at 48 months.

There is earlier evidence that immunisation incentives to providers positively impacts on coverage estimates.<sup>15</sup> However, the initial analyses in this report provides no evidence of a reduction in coverage associated with the removal of SIP payments in October 2008, while coverage at 60 months has increased following the due and overdue rule changes. More analysis is required to examine the impact of these changes in more detail.

A number of vaccines that are included in the NIP are not included when calculating 'fully immunised' status or in eligibility for incentive payments. Coverage estimates for 7vPCV and meningococcal C vaccines are comparable with estimates for vaccines that are included in 'fully vaccinated' calculations, but estimates for varicella and rotavirus are still substantially lower. During 2010, there were only slight changes in coverage for varicella (from 82% to 83%) and rotavirus vaccine (from 85% to 84%). For rotavirus vaccines, strict upper age limits for administration may explain lower coverage, whilst varicella is the only vaccine due at 18 months, and this milestone was historically problematic and lapsed for a two year period (2003 to 2005). The implications also vary. In the case of rotavirus vaccine, coverage of 80% or greater has been associated with substantial herd immunity and decreases in rotavirus hospitalisations in Australia and elsewhere.<sup>27</sup> By contrast, modelling studies suggest that low coverage with varicella vaccine may result in a shift of disease to older age groups with higher disease severity.<sup>28</sup>

Coverage for vaccines recommended for Indigenous children only (i.e. hepatitis A and 23vPPV), remained sub-optimal during 2010. The extent of under-reporting to the ACIR for these vaccines is unknown but likely to be more than for 'universal' vaccines, given the lack of incentive payments for notification to the ACIR. However, lower coverage for vaccines targeted at Indigenous people has been a relatively consistent finding using a range of different methods for both children and adults.<sup>14,30</sup> Both a lack of provider knowledge about the recommendations for high risk groups, and poor identification of Indigenous children by immunisation

**Figure 19: HPV vaccination coverage by dose number, females vaccinated between April 2007-December 2009, Australia**



Source: Human papillomavirus vaccination coverage data Australian Government. Department of Health and Ageing, April 2011. Available from: <http://www.immunise.health.gov.au/internet/immunise/publishing.nsf/Content/immunise-hpv>

12-13 years – School program

14-15 years – School catch up

16-17 years – School catch up

18-19 years – GP/community

20-26 years - GP/community

Includes only eligible consumers and vaccinations given as part of the National HPV Vaccination Program

Includes valid doses and too close doses for Clinically Complete Consumers

Population is Estimated Resident Population provided by the Australian Bureau of Statistics as at 30/06/2007

Age is age as at date of Estimated Resident Population estimate

Coverage is calculated as doses administered and reported to the NHVPR/estimated resident population expressed as a percentage

Excludes consumers who do not wish their details to be recorded on the HPV Register

Data is cumulative so covers all people over a three year period within each cohort (April 2007-December 2009)

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providers are likely to be important contributing factors. Differences in schedules between jurisdictions may also be a contributing factor. During 2010, coverage for both vaccines was still higher in the Northern Territory and Western Australia, which give the vaccines 6 months younger (hepatitis A, 12 and 18 months, 23vPPV 18 months), than in Queensland and South Australia (18 and 24, and 24 months). The presence of other vaccines on the schedule at the same age may assist achieving higher coverage, particularly at 12 months and less so at 18 months of age. Failure to receive a 2nd dose by 8% of children also contributed to the low coverage for hepatitis A vaccine. However, a protective antibody response after one dose is expected from a majority of children.<sup>31</sup>

Although coverage data reveal that most children eventually complete the scheduled vaccination

series by the 24-month milestone, many still do not do so in a timely manner. Vaccination delay in 2010 as measured in this report for vaccines assessed at 12 and 24 months of age has improved only marginally. However, timeliness cannot be measured in the most recent cohort, as time must be allowed for late vaccination to be received. An improvement in coverage seen at 60 months of age is reflected in much improved timeliness calculations in this age group for 2010. However, coverage 12 months after the due date of this vaccine is still <85%. Poorer timeliness in Indigenous children has been noted previously in infants. Timeliness has improved markedly at 60 months of age for both Indigenous and non-Indigenous children. However, as coverage and timeliness of vaccines assessed at 60 months of age has improved, a not previously seen disparity in timeliness between Indigenous and non-Indigenous children has emerged, as improvements in non-Indigenous children were not fully reproduced in Indigenous children. Delayed vaccination is a concern, especially for diseases where multiple vaccine doses are required for protection and the disease risk among young infants is significant (e.g. pertussis). Immunisation at the earliest appropriate age should be a public health goal for countries such as Australia where high levels of vaccine coverage at milestone ages have been achieved.

The ACIR has shown the rapid uptake of new vaccines and consistently high coverage for all vaccines, unlike some other developed countries.<sup>32,33</sup> In comparison with similar countries, reported coverage at 12 months of age is higher, and with almost 2% of children not vaccinated due to parental objection, targeting of on time vaccination is required to significantly improve the current levels of >91% 'fully immunised' at 12 months of age.<sup>33</sup> The reporting of national small area coverage data has not been noted elsewhere. Areas of low coverage have been identified in many remote areas and areas containing higher proportions of conscientious objectors. Vaccination timeliness has been reported elsewhere but not routinely.<sup>9</sup>

Coverage data for HPV from the national HPV register reflect a successful school-based program with lower coverage for the catch-up program.<sup>34,35</sup>

Coverage estimates for the elderly are comparable with other developed countries.<sup>36,37</sup>

Unfortunately, coverage data are not available for Indigenous adolescents. For adults, data are only available from the Aboriginal and Torres Strait Islander Health Survey, last conducted in 2004-05.<sup>38</sup>

Data provided in this report reflect continuing successful delivery of the NIP in Australia, while identifying some areas for improvement. Coverage for

varicella and rotavirus vaccines are below those for other vaccines, and is low in some small geographic areas. Timeliness of vaccination could be improved, particularly for Indigenous infants, and coverage for vaccines recommended only for Indigenous infants is lower than for other vaccines. It was recently announced that varicella and other NIP vaccines (meningococcal C and pneumococcal conjugate vaccines) will be included in coverage assessments for 'fully immunised', and thereby in eligibility for provider and parent incentives, from 2012.<sup>29</sup> It will be important to evaluate the impact of this change in coming years and given the encouraging improvements in timely coverage seen with the changes to reimbursement introduced in 2009 for the 48-month milestone, this promises to have a favourable impact especially for varicella vaccine where high coverage is crucial to long-term outcomes of the program.

### Author details

Brynely Hull  
Aditi Dey  
Rob Menzies  
Peter McIntyre

National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases The Children's Hospital at Westmead and University of Sydney Locked Bag 4001 Westmead, NSW 2145

### References

1. Hull B, Deeks S, Menzies R, et al. Immunisation coverage annual report, 2007. *Commun Dis Intell.* 2009;33:170-87.
2. Hull B, Mahajan D, Dey A, et al. Immunisation coverage annual report, 2008. *Commun Dis Intell.* 2010;34:241-58.
3. Hull B, Dey A, Mahajan D, et al. Immunisation coverage annual report, 2009. *Commun Dis Intell.* 2011;35:132-48.
4. Hull B, Lawrence G, MacIntyre CR, et al. Immunisation coverage: Australia 2001. Canberra: Commonwealth Department of Health and Ageing; 2002.
5. Hull BP, McIntyre PB, Heath TC, et al. Measuring immunisation coverage in Australia. A review of the Australian Childhood Immunisation Register. *Aust Fam Physician.* 1999;28:55-60.
6. Hull BP, Lawrence GL, MacIntyre CR, et al. Immunisation coverage in Australia corrected for under-reporting to the Australian Childhood Immunisation Register. *Aust NZ Public Health.* 2003;27:533-8.
7. Hull BP, McIntyre PB. Immunisation coverage reporting through the Australian Childhood Immunisation Register - an evaluation of the third-dose assumption. *Aust NZ Public Health.* 2000;24:17-21.
8. Hull BP, Lawrence GL, MacIntyre CR, et al. Estimating immunisation coverage: is the 'third dose assumption' still valid? *Commun Dis Intell.* 2003;27:357-61.
9. Hull BP, McIntyre PB. Timeliness of childhood immunisation in Australia. *Vaccine.* 2006;24:4403-8.
10. Hull BP, McIntyre PB. What do we know about 7vPCV coverage in Aboriginal and Torres Strait Islander children? *Commun Dis Intell.* 2004;28:238-43.

11. Hull BP, McIntyre PB, Couzos S. Evaluation of immunisation coverage for Aboriginal and Torres Strait Islander children using the Australian Childhood Immunisation Register. *Aust NZ Public Health*. 2004;28:47-52.
12. Hull BP, Lawrence GL, MacIntyre CR, et al. Is low immunisation coverage in inner urban areas of Australia due to low uptake or poor notification? *Aust Fam Physician*. 2003;32:1041-3.
13. Hull BP, McIntyre PB, Sayer GP. Factors associated with low uptake of measles and pertussis vaccines - an ecologic study based on the Australian Childhood Immunisation Register. *Aust NZ Public Health*. 2001;25:405-10.
14. Hull BP, Deeks S, Menzies R, et al. What do we know about 7vPCV coverage in Aboriginal and Torres Strait Islander children? A 2007 update. *Commun Dis Intell*. 2008;32:257-60.
15. Lawrence GL, MacIntyre CR, Hull BP, et al. Effectiveness of the linkage of child care and maternity payments to childhood immunisation. *Vaccine*. 2004;22:2345-50.
16. Lawrence GL, Hull BP, MacIntyre CR, et al. Reasons for incomplete immunisation among Australian children. A national survey of parents. *Aust Fam Physician*. 2004;33:568-71.
17. Australian Government Department of Human Services Medicare Australia. General Practice Immunisation Incentives (GPII) Scheme. 2007. Available from: <http://www.medicare.gov.au/provider/incentives/gpii/index.jsp#N100D3>
18. National Health and Medical Research Council. *The Australian immunisation handbook*. Canberra: Australian Government Department of Health and Ageing; 2013.
19. O'Brien ED, Sam GA, Mead C. Methodology for measuring Australia's childhood immunisation coverage. *Commun Dis Intell*. 1998;22:36-7.
20. Department of Health and Aged Care. Measuring Remoteness: Accessibility/Remoteness Index of Australia (ARIA). Occasional Papers, New Series No.14. Canberra: Department of Health and Aged Care; 2001.
21. Rank C, Menzies RI. How reliable are Australian Childhood Immunisation Register coverage estimates for indigenous children? An assessment of data quality and coverage. *Commun Dis Intell*. 2007;31:283-7.
22. Australian Bureau of Statistics. Australian Standard Geographical Classification (ASGC), 2001. Cat. no. 1216.0. Canberra: ABS; 2001.
23. MapInfo. MapInfo version 10.0 [computer program]. 7 ed. New York: MapInfo Corporation; 2009.
24. Australian Bureau of Statistics. Statistical Subdivision from Postal Area 2006 Concordance. Canberra: ABS; 2007. Available from: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/39433889d406eeb9ca2570610019e9a5/5942283858e38743ca25730c00009f2e!OpenDocument>.
25. Department of Health and Ageing. Immunise Australia. Human Papillomavirus (HPV). Available from: <http://www.immunise.health.gov.au/internet/immunise/publishing.nsf/Content/immunise-hpv>
26. Australian Institute of Health and Welfare. 2009 Adult Vaccination Survey – Summary results. Cat. No. PHE 135.. Canberra. 2011.
27. BATTERY JP, Lambert SB, Grimwood K, et al. Reduction in rotavirus-associated acute gastroenteritis following introduction of rotavirus vaccine into Australia's National Childhood vaccine schedule. *Pediatr Infect Dis*. 2011 Jan;30:525-9.
28. Brisson M, Edmunds W, Gay N, et al. Modelling the impact of immunization on the epidemiology of varicella zoster virus. *Epidemiol Infect*. 2000;125:651-69.
29. Department of Health and Ageing. Immunise Australia Program. Available from: <http://www.health.gov.au/internet/immunise/publishing.nsf/Content/home>
30. Menzies R, Turnour C, Chiu C, et al. Vaccine preventable diseases and vaccination coverage in Aboriginal and Torres Strait Islander people, Australia 2003 to 2006. *Commun Dis Intell*. 2008;32 Suppl:S2-S67.
31. Plotkin S, Orenstein WA, Offit PA. Vaccines 5th Edition: Elsevier; 2008.
32. Centre of Disease Control and Prevention. National, state, and local area vaccination coverage among children aged 19-35 months - United States, 2008. *MMWR*. 2009;58:921-6.
33. Health Protection Agency. NHS Immunisation Statistics, England 2008-09 Report. The Health and Social Care Information Centre; 2009.
34. Ward KF, Menzies RI, Quinn HE, Campbell-Lloyd S. School-based vaccination in NSW. *NSW Public Health Bull*. 2010;21(9-10):237-42.
35. Brotherton J, Gertig D, Chappell G, Rowlands L, Saville M. Catching up with the catch-up: HPV vaccination coverage data for Australian women aged 18-26 years from the National HPV Vaccination Program Register. *Commun Dis Intell*. 2011;35(2):197-201.
36. The NHS Information Centre, Public Health Indicators and Population Statistics Team. NHS Immunisation Statistics England 2009-10. Available from: [http://www.ic.nhs.uk/webfiles/publications/003\\_Health\\_Lifestyles/immstats0910/Immunisations\\_Bulletin\\_2009-10.pdf](http://www.ic.nhs.uk/webfiles/publications/003_Health_Lifestyles/immstats0910/Immunisations_Bulletin_2009-10.pdf)
37. CDC. Prevention and control of influenza: recommendations of the Advisory Committee on Immunization Practices [ACIP]. *MMWR* 2010;59[No. RR-08].
38. Australian Bureau of Statistics. National Aboriginal and Torres Strait Islander Health Survey, 2004-05. Cat. No. 4715.0. Canberra. 2006.