Paediatric SARS-CoV-2 serosurvey 2022, Australia Summary report

3 November 2022

Key findings

- This study reports on the proportion of children aged 0–19 years from across Australia who had antibodies to SARS-CoV-2 and/or COVID-19 vaccination in their blood detected by August 2022.
- Antibodies to the spike protein, which is a marker of infection in unvaccinated children (including all children aged 1–4 years), were detected in 79% of children aged 1–4 years and 82% of children aged 0–19 years who were unvaccinated.
- Antibodies to the nucleocapsid protein, which is a marker of recent infection and useful in understanding infection rates in vaccinated population, were detected in 64% of children, with the highest rates seen in teenagers (70%) and lower rates in children aged 1–4 years (61%).
- Infants aged <1 year also had evidence of infection; however, this was more challenging to interpret because of the potential to also detect maternal antibodies.
- This study indicates most children and adolescents in Australia have been infected with the virus that causes COVID-19. Low rates of hospitalisations in this age group suggest that both younger age and vaccination are protective against severe disease.

Introduction

SARS-CoV-2, the virus that causes COVID-19, can infect people of any age; however, severe outcomes in children and adolescents are much less common than in adults.[1-3] Data on notified cases of COVID-19 underestimate the true number of infections occurring in the population due to factors such as asymptomatic infections and lack of testing (e.g. because of mild illness or other factors).

Serosurveys measure the proportion of individuals in a population who have antibodies to SARS-CoV-2 in their blood. SARS-CoV-2 is encased with four structural proteins, including spike and nucleocapsid proteins. The COVID-19 vaccines used in Australia only make antibodies to components of the spike protein. The presence of antibodies to the spike protein in the blood is therefore a marker of either vaccination and/or infection. Antibodies to nucleocapsid protein only occur after infection.

The National Centre for Immunisation Research and Surveillance (NCIRS) and the Australian COVID-19 Serosurveillance Network have been conducting regular serological surveys in Australian blood donors (aged 18 years and older) during 2022 to estimate the proportion of adults that have SARS-CoV-2 antibodies. At least 17% of the adult population had been infected with SARS-CoV-2 by February 2022, 46% by June 2022[4,5] and 65% by September 2022.[6] Much less information is available on COVID-19 infection rates in children, as most children do not have blood tests taken routinely.

In early 2021, before the COVID-19 vaccine roll-out and the Delta variant outbreak, less than <0.6% of children and adolescents aged 0–18 years had evidence of infection.[7] COVID-19 vaccination has been available for adolescents aged 12 years and older since July 2021, and for children aged 5 years and older since February 2022. Since the pandemic commenced, around 3 out of every 10 children have been reported as having had COVID-19, most since late 2021 when the Omicron variant began to circulate.

This study aimed to estimate the seroprevalence of SARS-CoV-2 spike and nucleocapsid antibodies in children and adolescents aged 0–19 years by August 2022.

Methods

Children undergoing an anaesthetic procedure (e.g. for day surgery, trauma or other reason) were recruited for this study through eight paediatric hospitals of the Paediatric Active Enhanced Disease Surveillance (PAEDS) network across Australia. Children who were immunosuppressed or receiving intravenous immunoglobulin were excluded due to the possibility that they may not have a strong antibody response to infection or they may have had donor antibody from the blood product donation, respectively. Parents of the children or adolescents recruited also completed a survey to provide information on participant vaccination history, underlying medical conditions and if they had had COVID-19 in the past. Vaccinations received were confirmed using the Australian Immunisation Register.

Blood samples were collected from 8 June 2022 to 31 August 2022 and de-identified for analysis. Antibody testing was done at the Victorian Infectious Diseases Reference Laboratory (VIDRL) using the Roche Elecsys SARS-CoV-2 Spike and Nucleocapsid Total Antibody Test.[8] Data were analysed according to the presence of antibody levels above standard cut-off values, and not adjusted for test sensitivity or specificity.

Results

A total of 2,306 children and adolescents were recruited. Samples were collected from 2,057 individuals, of which 2,046 samples were viable for laboratory analysis (refer to Table 1). There were more males than females (57% versus 43%). There were 26% of children recruited from New South Wales, 20% from South Australia, 19% from Victoria, 17% from Queensland, 13% from Western Australia and 5% from the Northern Territory.

Table 1: Proportion of children aged 0–19 years with SARS-CoV-2 spike and nucleocapsid antibodies, by jurisdiction and nationally

Jurisdiction	Spike antibody positive/total tested specimens (%)	Nucleocapsid antibody positive/total tested specimens (%)
New South Wales	471/511 (92)	338/511 (66)
Victoria	367/400 (92)	271/400 (68)
South Australia	367/399* (92)	227/400 (57)
Queensland	316/352 (90)	240/352 (68)
Western Australia	228/281 (81)	166/281 (59)
Northern Territory	84/102 (82)	67/102 (66)
Total	**1833/2045 (90)**	**1309/2046 (64)**

* Note: One sample from Women's and Children's Hospital, SA, was not sufficient to test for spike protein in addition to nucleocapsid, therefore, total samples for spike antibody analysis = 2,045**;** Jurisdiction refers to the place of collection, noting that a few individuals may have travelled interstate for their procedure.

Spike antibodies were detected in 1,833 individuals (90%) and nucleocapsid antibodies in 1,309 individuals (64%) (refer to Table 2). In those who reported no history of past infection, spike antibodies were detected in 831 (82%) individuals and nucleocapsid antibodies in 387 individuals (38%) (refer to Table 2).

Table 2: Proportion of children aged 0–19 years with SARS-CoV-2 spike and nucleocapsid antibodies, by age group, sex, Indigenous status and pre-existing conditions

Type of antibody	SARS-CoV-2 Spike antibody	SARS-CoV-2 Nucleocapsid antibody
Presence of antibody	Positive n/N (%)	Positive n/N (%)
Age group (years)		
0 – <6 months	58/63 (92)	21/63 (33)
6 – <12 months	66/81 (81)	42/81 (52)
1–4	529/671 (79)	407/671 (61)

5–11	650/696 (93)	465/696 (67)
12–15	394/397 (99)	278/397 (70)
16–19	136/137 (99)	96/138 (70)
Total	1833/2045 (90)	1309/2046 (64)
Sex		
Male	1039/1171 (89)	732/1172 (62)
Female	792/872 (91)	576/872 (66)
Other/non-specified	2/2 (100)	1/2 (50)
Indigenous status		
Indigenous	158/176 (90)	114/176 (65)
Non-Indigenous	1674/1868 (90)	1194/1869 (64)
Pre-existing medical conditions		
Present	648/735 (88)	434/736 (59)
None	1185/1310 (90)	875/1310 (67)
Reported history of past infection		
Yes	992/1013 (98)	914/1014 (90)
No	831/1019 (82)	387/1019 (38)

Table 3 shows presence of SARS-CoV-2 spike and nucleocapsid antibodies by vaccination status and age. Of the 1,170 individuals who were unvaccinated, 961 (82%) had spike antibodies detected and 739 (63%) nucleocapsid antibodies. All vaccinated individuals had spike antibodies detected and 65% of those vaccinated also had evidence of nucleocapsid antibodies, indicating past infection. Refer also to Figure 1.

In children aged 1–4 years, none of whom were eligible for vaccination at the time of the study, most who had a reported history of SARS-CoV-2 infection (307; 96%) were spike antibodies positive and 275 (86%) were nucleocapsid antibodies positive. Refer also to Figure 2.

193 (8%) children in the study identified as Aboriginal and Torres Strait Islander, and 176 of these children had their blood sample tested. Aboriginal and Torres Strait Islander children had a very similar proportion of spike antibodies (90%) and nucleocapsid antibodies (65% versus 64%) as non-Indigenous children (refer to Table 2).

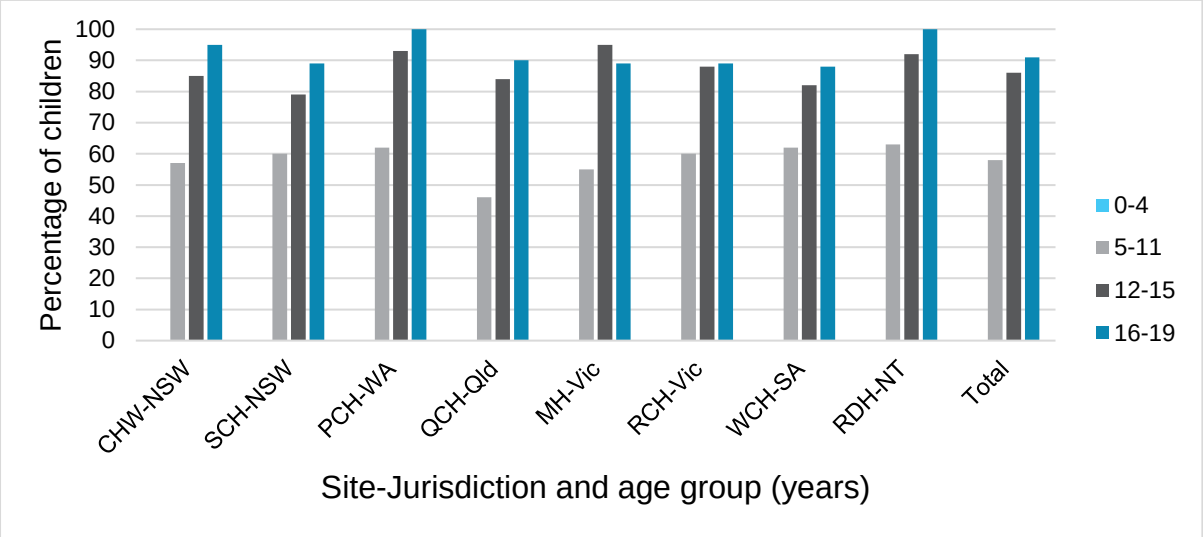
Around one third of all children in the study (844; 37%) had at least one pre-existing medical condition.

Table 3: Proportion of children aged 0–19 years with SARS-CoV-2 spike and nucleocapsid antibodies, by COVID-19 vaccination status and age

		Total			
Vaccinated*		Yes		No	
Antibody detection		Spike positive n (%)	Nucleocapsid positive n (%)	Spike positive n (%)	Nucleocapsid positive n (%)
Age group	0 – <6 months	0/0 (0)	0/0 (0)	58/60 (92)	21/63 (33)
	6 – <12 months	0/0 (0)	0/0 (0)	66/81 (81)	42/81 (51)
	1–4 years	0/0 (0)	0/0 (0)	529/671 (79)	407/671 (61)
	5–11 years	401/401 (100)	247/401 (62)	249/295 (84)	218/295 (74)
	12–15 years	337/337 (100)	229/337 (68)	53/56 (95)	45/56 (80)
	16–19 years	123/123 (100)	85/124 (69)	11/12 (92)	10/12 (83)
Total		861/861 (100)	561/862 (65)	961/1170 (82)	739/1170 (63)

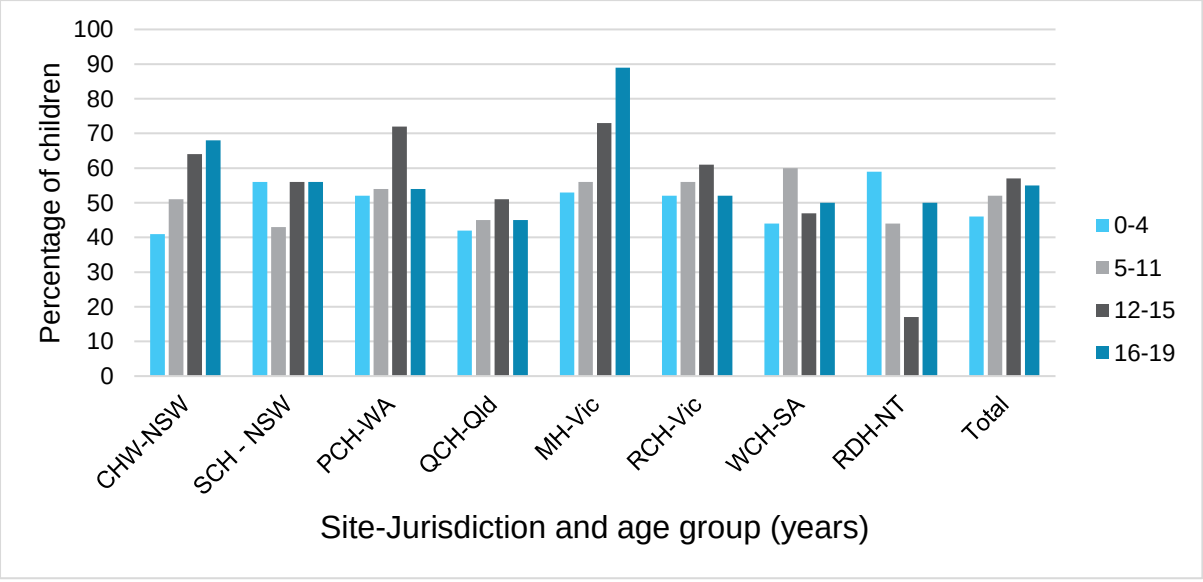
* Vaccinated refers to receipt of at least one dose of COVID-19 vaccine. Total includes 8 children aged 0–4 years whose Australian Immunisation Register record could not be found and they were included as “not vaccinated” (parental recollection also noted not vaccinated for these children).

Figure 1: The proportion of children tested for antibodies to SARS-COV-2 (n=2,287) who had at least one dose of COVID-19 vaccine in the past*



* Children had blood samples collected between 8 June and 31 August 2002. At this time, children aged <5 years were not eligible for vaccination.
CHW-NSW - Children’s Hospital at Westmead, New South Wales; SCH-NSW - Sydney Children’s Hospital Randwick, New South Wales; RCH-VIC - Royal Children’s Hospital, Melbourne, Victoria; MH-VIC - Monash Health, Victoria; WCH-SA - Women’s and Children’s Hospital, Adelaide, South Australia; PCH-WA - Perth Children’s Hospital, Western Australia; RDH-NT - Royal Darwin Hospital, Northern Territory; QCH-QLD - Queensland Children’s Hospital, Queensland

Figure 2: The proportion of children tested for antibodies to SARS-COV-2 (n=2,306) who had a parent/self-reported history of COVID-19 infection



CHW-NSW - Children’s Hospital at Westmead, New South Wales; SCH-NSW - Sydney Children’s Hospital Randwick, New South Wales; RCH-VIC - Royal Children’s Hospital, Melbourne, Victoria; MH-VIC - Monash Health, Victoria; WCH-SA - Women’s and Children’s Hospital, Adelaide, South Australia; PCH-WA - Perth Children’s Hospital, Western

Australia; RDH-NT - Royal Darwin Hospital, Northern Territory; QCH-QLD - Queensland Children's Hospital, Queensland

Discussion

This serosurvey suggests that by August 2022 at least 64% of Australian children had been infected with SARS-CoV-2 recently, likely in the past year. There was also a high rate of spike antibodies in unvaccinated children (82%), suggesting at least 4 out of 5 unvaccinated children have been infected. While spike antibodies were universally detected in vaccinated individuals, as expected, 65% of vaccinated individuals also had nucleocapsid antibodies, signifying past infection. At least 38% of children whose parents reported they had not previously been infected had evidence of infection due to the presence of nucleocapsid antibodies, suggesting asymptomatic or mild infection that may have been unrecognised.

In all children, the true cumulative SARS-CoV-2 infection rate is likely to be higher than that indicated by nucleocapsid seroprevalence, as data suggest that the sensitivity to detect nucleocapsid antibodies in vaccinated adults with breakthrough Omicron infections is around 84% (95% CI: 76–90%). Antibodies to nucleocapsid protein have also been shown to wane more rapidly in the post-infectious phase while antibodies to spike protein appear to persist more over time.[9-11] A high prevalence of spike antibodies (82%) compared with nucleocapsid antibodies (63%) was found in unvaccinated children, suggesting that spike antibody is a more sensitive marker of past infection in unvaccinated individuals.

In children aged >1 year, there was an increasing prevalence of nucleocapsid antibodies, rising from 61% in 1–4 year olds to 83% in 16–17 year olds, suggesting increasing rates of infection with age, irrespective of vaccination. Children with pre-existing medical conditions had a slightly lower rate of nucleocapsid antibodies prevalence (59% versus 67% in those without medical conditions), suggesting lower rates of infection in this potential risk group.

Infants aged <1 year had lower prevalence of nucleocapsid antibodies (33–52%) compared with older age groups. Both assays used detect IgG antibody and this type of antibody is actively transported via the placenta to the foetus in late second and third trimester. Thus, antibodies present in infants aged <6 months and sometimes up to a year may represent antibodies from maternal vaccination or prior infection and/or antibodies from infection in the infant themselves. It is not possible to distinguish this.

Conclusion

This seroprevalence study suggests there have been high rates of infection in children and adolescents of all ages across Australia, including those whose parents had not suspected infection and in vaccinated children. These infection rates contrast with the total COVID-19 cases reported across the Australian population – around 10.3 million cases reported in 26 million people to end August 2022, but are consistent with the high rates of antibody prevalence indicating past infection in adults.

This finding is not unexpected, given SARS-CoV-2 continues to circulate in the community and the highly transmissible nature of the current Omicron variant. However, children, especially those who are vaccinated, rarely experience severe disease. For example, although we show evidence of higher rates of infection in unvaccinated pre-school age children, this has not been accompanied by a high rate of hospitalisation for complications of COVID-19;[7,12-13] both of these findings support the decision to limit vaccination of children aged 6 months to <5 years to only those with underlying medical conditions that put them at higher risk for complications of COVID-19.[14]

Seroprevalence studies provide one important line of evidence to better understand virus transmission in the community and to gain insights into how immunity, derived from both vaccination and infection, provides protection against severe COVID-19.

PAEDS study sites

- The Children's Hospital at Westmead (CHW), New South Wales
- Sydney Children's Hospital Randwick (SCH), New South Wales
- Royal Children's Hospital (RCH), Melbourne, Victoria
- Monash Health (MCH), Victoria
- Women's and Children's Hospital (WCH), Adelaide, South Australia

- Perth Children's Hospital (PCH), Western Australia
- Royal Darwin Hospital (RDH), Northern Territory
- Queensland Children's Hospital (QCH), Queensland

Collaborators

- Murdoch Children's Research Institute (MCRI), Melbourne, Victoria
- Victorian Infectious Diseases Reference Laboratory (VIDRL)
- NSW Health Pathology, Institute of Clinical Pathology and Medical Research (ICPMR)

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