

Rapid evidence checks are based on a simplified review method and may not be entirely exhaustive, but aim to provide a balanced assessment of what is already known about a specific problem or issue. This brief has not been peer-reviewed and should not be a substitute for individual clinical judgement, nor is it an endorsed position of NSW Health.

## COVID-19 infectivity and transmission in children

### Rapid review question

What is the evidence on the infection rate, infectivity and transmission of COVID-19 in children?

### In brief

- Publications have generally found a lower attack rate in children compared to adults.
- Prevalence of COVID-19 infection is reported to be lower in children than in adults, however prevalence can be difficult to determine in children as most present with mild or no apparent symptoms.
- There is preliminary evidence that children and young people have lower susceptibility to COVID-19, with a 56% lower odds of being an infected contact compared with adults.
- To date, children are rarely the index case in reports of household clusters in the literature.
- There is weak evidence that children and young people play a lesser role in transmission of COVID-19 at a population level.
- A systematic review of the impact of school closures on the transmission of COVID-19 found no data on the relative contribution of school closures to transmission control. Data from the SARS outbreak suggested that school closures did not contribute to the control of the epidemic.

### Limitations

Evidence relating to the infectivity and transmission of COVID-19 in children is scarce. The primary publications from the reviews and meta-analysis included were not individually reviewed.

### Background

Children have so far accounted for 1%-5% of diagnosed COVID-19 cases, they often have milder disease than adults and deaths have been rare.(1)

## Methods (Appendix 1)

PubMed and grey literature searches were conducted 30 May 2020. Systematic reviews on transmission and infectivity in children were included, and primary research including empirical data on attack rate or children as index cases were included. Publications on neonates were out of scope for this review.

## Results

**Table 1: Peer reviewed literature: COVID-19 infection and transmission in children**

| Source  | Summary   |
|---|---|
| <b>Peer reviewed sources</b>  |   |
| <p><a href="#">SARS-CoV-2 (COVID-19): What do we know about children? A systematic review</a></p> <p>Mehta, et al. 2020 (2)</p>   | <ul style="list-style-type: none"> <li>• 24 studies were included.</li> <li>• Children appear to be less affected than adults by COVID-19 as shown by observed rate of cases in large epidemiological studies.</li> <li>• Limited data on attack rate indicate that children are just as susceptible to infection.</li> <li>• Data on clinical outcomes are scarce but include several reports of asymptomatic infection and a milder course of disease in young children, though radiological abnormalities are noted.</li> <li>• Severe cases are not reported in detail and there are little data relating to transmission.</li> </ul> |
| <p><a href="#">School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review</a></p> <p>Viner, et al. 2020 (3)</p> | <ul style="list-style-type: none"> <li>• 16 studies were included.</li> <li>• China and Hong Kong.</li> <li>• No data on the relative contribution of school closures to transmission control.</li> <li>• Data from the SARS outbreak in mainland China, Hong Kong, and Singapore suggest that school closures did not contribute to the control of the epidemic.</li> <li>• Modelling studies of SARS produced conflicting results. Recent modelling studies of COVID-19 predict that school closures alone would prevent only 2-4% of deaths, much less than other social distancing interventions.</li> </ul>                          |

| Source  | Summary   |
|---|---|
| <b>Peer reviewed sources</b>  |   |
| <p><a href="#">Children are unlikely to be the main drivers of the COVID-19 pandemic - a systematic review</a><br/>Ludvigsson 2020 (4)</p>  | <ul style="list-style-type: none"> <li>• 47 studies were included.</li> <li>• Children accounted for a small fraction of COVID-19 cases.</li> <li>• Children mostly had social contacts with peers or parents, rather than older people at risk of severe disease.</li> <li>• Data on viral loads were scarce, but indicated that children may have lower levels than adults, partly because they often have fewer symptoms, and this should decrease the transmission risk.</li> <li>• Household transmission studies showed that children were rarely the index case and case studies suggested that children with COVID-19 rarely caused outbreaks.</li> <li>• However, it is highly likely that children can transmit the SARS-COV-2 virus, and even asymptomatic children can have viral loads.</li> </ul> |
| <p><a href="#">Epidemiology and transmission of COVID-19 in 391 cases and 1286 of their close contacts in Shenzhen, China: a retrospective cohort study</a><br/>Bi, et al. 2020 (5)</p> | <ul style="list-style-type: none"> <li>• This study assessed 1286 contacts of 391 initial cases.</li> <li>• The household secondary attack rate was 11(2%) (95% CI 9.1-13.8), and children were as likely to be infected as adults (infection rate 7(4%) in children &lt;10 years vs population average of 6(6%).</li> <li>• Children are at a similar risk of infection to the general population, although less likely to have severe symptoms.</li> </ul>  |
| <p><a href="#">The characteristics of household transmission of COVID-19</a><br/>Li, et al. 2020 (6)</p>  | <ul style="list-style-type: none"> <li>• Total 105 index patients and 392 household contacts were enrolled.</li> <li>• Of the 100 contacts under 18 years of age, only four became infected. The secondary attack rate to children was 4% comparing with 17.1% to adults.</li> </ul>  |

| Source   | Summary  |
|--|--|
| <b>Peer reviewed sources</b>   |  |
| <p><a href="#">Changes in contact patterns shape the dynamics of the COVID-19 outbreak in China</a><br/>Zhang, et al. 2020 (7)</p> | <ul style="list-style-type: none"> <li>• Study analysed 1,245 contacts reported by 636 study participants in Wuhan, and 1,296 contacts reported by 557 participants in Shanghai.</li> <li>• The authors found that children 0-14 years are less susceptible to SARS-CoV-2 infection than adults 15-64 years (odds ratio 0.34, 95%CI 0.24-0.49)</li> </ul>  |
| <p><a href="#">Spread of SARS-CoV-2 in the Icelandic population</a><br/>Gudbjartsson, et al. 2020 (8)</p>                          | <ul style="list-style-type: none"> <li>• As of 4 April 2020, a total of 1,221 of 9,199 persons (13.3%) who were recruited for targeted testing had positive results for infection with SARS-CoV-2.</li> <li>• Children under 10 years of age were less likely to receive a positive result than were persons 10 years of age or older, with percentages of 6.7% and 13.7%, respectively, for targeted testing.</li> <li>• In the population screening, no child under 10 years of age had a positive result, as compared with 0.8% of those 10 years of age or older.</li> </ul>   |
| <p><a href="#">Cluster of coronavirus disease 2019 (Covid-19) in the French Alps, 2020</a><br/>Danis, et al. 2020 (9)</p>          | <ul style="list-style-type: none"> <li>• A confirmed case of SARS-CoV-2 coronavirus in an Englishman infected in Singapore who had recently stayed in a chalet in the French Alps.</li> <li>• Authors defined as a confirmed case a person linked to the chalet with a positive RT-PCR sample for SARS-CoV-2.</li> <li>• The index case stayed four days in the chalet with 10 English tourists and a family of 5 French residents; SARS-CoV-2 was detected in 5 individuals in France, 6 in England (including the index case), and 1 in Spain (overall attack rate in the chalet: 75%).</li> <li>• One paediatric case, with picornavirus and influenza A coinfection, visited three different schools while symptomatic. This case did not transmit the virus to anyone else despite close interactions within schools.</li> <li>• Additionally, 172 contacts were monitored, including 73 who tested negative for SARS-CoV-2.</li> </ul> |

| Source  | Summary  |
|---|--|
| <b>Peer reviewed sources</b>  |  |
| <p><a href="#">[Epidemiological characteristics of 2019 novel coronavirus family clustering in Zhejiang Province]</a><br/>Sun, et al. 2020 (10)<br/><i>Article in Chinese</i></p> | <ul style="list-style-type: none"> <li>• 391 cases including 148 family index cases, 189 subsequent cases and 54 asymptomatic infected cases.</li> <li>• Family secondary attack rate for subsequent cases and asymptomatic infected cases are 31.61% and 43.20% respectively, the family secondary attack rate of the spouses of the family index cases is 63.87%, and is higher than that of their children (30.53%), parents (28.37%) and other family members (20.93%), the difference was statistically significant.</li> </ul>           |
| <p><a href="#">High COVID-19 attack rate among attendees at events at a church - Arkansas, March 2020</a><br/>James, et al. 2020 (11)</p>   | <ul style="list-style-type: none"> <li>• Two cases from a rural town in Arkansas.</li> <li>• The two cases occurred in a husband and wife; the husband is the pastor at a local church (church A).</li> <li>• Including the index cases, 35 confirmed COVID-19 cases occurred among 92 (38%) persons who attended events held at church A during 6-11 March 2020. Three patients died.</li> <li>• The age-specific attack rates among persons aged ≤18 years, 19-64 years, and ≥65 years were 6.3%, 59.4%, and 50.0%, respectively.</li> </ul> |

**Table 2: Pre-peer review articles: COVID-19 infection and transmission in children**

| Source  | Summary  |
|---|--|
| <b>Pre-peer review publications</b>   |  |
| <p><a href="#">Age specificity of cases and attack rate of novel coronavirus disease (COVID-19)</a><br/>Mizumoto, et al. 2020 (12)</p>    | <ul style="list-style-type: none"> <li>• Examined age distribution of COVID-19 cases in Japan from January to March, 2020.</li> <li>• Children were less likely to be diagnosed as cases, and moreover, the risk of disease given exposure among children appears to be low</li> <li>• Both the overall risk and the conditional risk of disease given exposure are likely to be the highest among adults aged from 50-69 years</li> </ul>   |
| <p><a href="#">Household secondary attack rate of COVID-19 and associated determinants</a><br/>Jing, et al. 2020 (13)</p>                 | <ul style="list-style-type: none"> <li>• Based on a comprehensive contact-tracing dataset from Guangzhou, estimated both the population-level effective reproductive number and individual-level secondary attack rate in the household setting.</li> <li>• The odds of infection among children (age &lt;20 years) was 0.26 compared with those aged 60+ years.</li> </ul>  |
| <p><a href="#">Children are unlikely to have been the primary source of household SARS-CoV-2 infections</a><br/>Zhu, et al. 2020 (14)</p> | <ul style="list-style-type: none"> <li>• Analysis of literature published between December 2019 and March 2020.</li> <li>• Clinical features of SARS-CoV-2 in children and descriptions of household transmission clusters.</li> <li>• Of the 31 household transmission clusters that were identified, 9.7% (3/31) were identified as having a paediatric index case. This is in contrast other zoonotic infections (namely H5N1 influenza virus) where 54% (30/56) of transmission clusters identified children as the index case.</li> </ul> |
| <p><a href="#">An analysis of SARS-CoV-2 viral load by patient age</a><br/>Jones, et al. 2020 (15)</p>                                    | <ul style="list-style-type: none"> <li>• Estimated viral load using real-time RT-PCR threshold cycle values from 3,712 COVID-19 patients.</li> <li>• Analysis of variance of viral loads in patients of different age categories found no significant difference between any pair of age categories including children.</li> <li>• Data indicate that viral loads in the very young do not differ significantly from those of adults.</li> </ul>   |

| Source  | Summary  |
|---|--|
| <b>Pre-peer review publications</b>   |  |
| <p><a href="#">No SARS-CoV-2 carriage observed in children attending daycare centers during the first weeks of the epidemic in Belgium</a></p> <p>Desmet, et al. 2020 (16)</p>                    | <ul style="list-style-type: none"> <li>• A random sample of children (n=84) aged between 6 and 30 months attending day care in Belgium was studied shortly after the start of the epidemic and before the lockdown.</li> <li>• No asymptomatic carriage of SARS-CoV-2 was detected, whereas common cold symptoms were common (51.2%).</li> </ul>   |
| <p><a href="#">Susceptibility to and transmission of COVID-19 amongst children and adolescents compared with adults: a systematic review and meta-analysis</a></p> <p>Viner, et al. 2020 (17)</p> | <ul style="list-style-type: none"> <li>• A rapid systematic review of contact-tracing studies and population-screening studies.</li> <li>• Included 18 studies.</li> <li>• Meta-analysis of contact tracing studies showed that the pooled odds ratio of being an infected contact in children compared with adults for all contact tracing studies was 0.44 (0.29, 0.69) with substantial heterogeneity (63%).</li> <li>• Systematic review of household clusters of COVID-19 found 3/31 (10%) were due to a child index case and a population-based school contact tracing study found minimal transmission by child or teacher index cases</li> <li>• Large studies from Iceland, the Netherlands and Spain and an Italian municipal study showed markedly lower SARS-CoV-2 prevalence amongst children and young people, however studies from England, Stockholm and municipalities in Switzerland and Germany showed no difference in infection prevalence between adults and children.</li> <li>• There is preliminary evidence that children and young people have lower susceptibility to SARS-CoV-2, with a 56% lower odds of being an infected contact. There is weak evidence that children and young people play a lesser role in transmission of SARS-CoV-2 at a population level.</li> </ul> |

**Table 3: Grey literature COVID-19 infection and transmission in children**

| Source  | Summary   |
|---|---|
| <b>Grey literature</b>  |   |
| <p><a href="#">COVID-19 in schools – the experience in NSW</a><br/>NCIRS, 2020 (18)</p>   | <ul style="list-style-type: none"> <li>• In NSW, from March to mid-April 2020, 18 individuals (9 students and 9 staff) from 15 schools were confirmed as COVID-19 cases; all of these individuals had an opportunity to transmit the COVID-19 virus (SARS-CoV-2) to others in their schools.</li> <li>• 735 students and 128 staff were close contacts of these initial 18 cases.</li> <li>• One child from a primary school and one child from a high school may have contracted COVID-19 from the initial cases at their schools.</li> <li>• No teacher or staff member contracted COVID-19 from any of the initial school cases.</li> </ul>  |
| <p><a href="#">Australian Health Protection Principal Committee (AHPPC) coronavirus (COVID-19) statement on 3 April 2020</a><br/>Australian Government, Department of Health, 2020 (19)</p> | <ul style="list-style-type: none"> <li>• There is limited information on the contribution of children to transmission of COVID-19.</li> <li>• The WHO-China Joint Mission observed that children tended to be infected by adults in the household. In China, 2.4% of total reported cases were under the age of 19 years. Worldwide, of those cases under 19 years of age, very few were severe or critical.</li> <li>• The clinical picture in paediatric patients infected with SARS-CoV-2 contrasts distinctly with the severity pattern observed with other respiratory viruses, where young children are particularly at risk of severe disease.</li> <li>• The health evidence on school closures from previous respiratory epidemics remains that the costs are often underestimated and the benefits are overestimated. The best available modelling supports the hypothesis that children are infected but relatively asymptomatic. If we assume that asymptomatic people are less likely to transmit, the modelling indicates that school closures will have minimal impact on the overall epidemiology of COVID-19 in the Australian setting.</li> </ul> |

| Source  | Summary  |
|---|--|
| <b>Grey literature</b>  |  |
| <p><a href="#">The missing link: children and transmission of SARS-COV-2</a><br/>Munro, et al. 2020 (20)</p>                          | <ul style="list-style-type: none"> <li>• Children appear significantly less likely to acquire COVID-19 than adults when exposed.</li> <li>• There is reasonable evidence that there are significantly fewer children infected in the community than adults.</li> <li>• Children are rarely the index case in a household cluster in the literature to date.</li> <li>• It is not clear how likely an infected child is to pass on the infection compared to an infected adult, but there is no evidence that they are any more infectious.</li> </ul> <p>[Cites COVID-19 studies: from Guangzhou - where 5% of index cases were noted to be children (Jing et al, 2020); from Hunan, where only one of the 114 clusters identified a child under 14 years of age as the index case in the household (Zhang et al, 2020); and an international study of family clusters, where a child was found to be the index case in a household in only 10% of clusters (Zhu et al, 2020)) See also DFTB COVID-19 evidence review 15th MAY 2020]</p>   |
| <p><a href="#">COVID-19 research evidence summaries: transmission</a><br/>Royal College of Paediatrics and Child Health 2020 (21)</p> | <p><b>Can children transmit the virus?</b></p> <ul style="list-style-type: none"> <li>• The importance of children in transmitting the virus is difficult to establish, in particular given the number of asymptomatic cases.</li> <li>• Some evidence that their role in transmitting the virus is fairly limited.</li> <li>• Precise details regarding paediatric transmission cannot be confirmed without widespread sero-surveillance.</li> <li>• Studies of multiple family clusters have revealed children were unlikely to be the index case.</li> <li>• There is some evidence of asymptomatic transmission, but also a signal that symptomatic patients present a higher risk of transmitting the virus than those who do not develop symptoms.</li> <li>• A recent systematic review and meta-analysis of the available data on susceptibility and transmission in children and adolescents, suggests that overall transmission rates in children are lower than those in adults, but there is considerable heterogeneity in the data. In the Netherlands, separate data from primary care and household studies suggests SARS-CoV-2 is mainly spread between adults and from adult family members to children.</li> </ul> |

| Source  | Summary   |
|---|---|
| <b>Grey literature</b>  |   |
|   | <p><b>What is the duration of viral shedding in nasopharyngeal or throat swabs?</b></p> <ul style="list-style-type: none"> <li>The duration of viral shedding (in naso-pharyngeal or throat swabs) has been reported in children to range from 6-22 days (median 12 days).</li> </ul> <p><b>Can children transmit the virus through their stool?</b></p> <ul style="list-style-type: none"> <li>Several studies have detected viral RNA in the stool of affected infants.</li> <li>Research from Germany did not identify any live, culturable virus in stool despite viral RNA being detectable. Subsequent reports, however, indicate that there has been infectious virus in stool identified, but how much and how infectious is not yet clear as it is not quantified.</li> </ul>  |
| <p><a href="#">Can children transmit the new coronavirus to other people?</a><br/>Lewis 2020 (22)</p> | <p>Overview of evidence, including peer review studies featured in Table 1</p> <ul style="list-style-type: none"> <li>One 9-year-old boy with COVID-19 in a contact tracing study in the French Alps. The boy visited three schools whilst symptomatic, but the researchers found no evidence of transmission of the virus to other pupils.</li> <li>Children are very rarely the first person to develop COVID-19 symptoms within a household however: cites Zhu et al (2020) who found three instances where a child under 10 was the index case within a household.</li> <li>There are no 'direct experiments comparing exposure to an infected child to exposure to an infected adult'.</li> <li>The UK's Royal College of Paediatrics and Child Health notes that high-quality evidence from widespread sero-surveillance studies is needed to reliably quantify the risk of transmission of the new coronavirus from children to other people. Many studies are currently in progress.</li> </ul> |

| Source   | Summary   |
|--|---|
| <b>Grey literature</b>   |   |
| <p><a href="#">Children and COVID-19</a></p> <p>National Institute for Public Health and the Environment, Netherlands (23)</p> | <ul style="list-style-type: none"> <li>• National Institute for Public Health and the Environment set up a study on people infected with COVID-19 and their family contacts.</li> <li>• A total of 54 households took part up to mid-April 2020, involving 239 participants, including 185 housemates.</li> <li>• This involves 123 adults and 116 children between the ages of 1 and 16 years.</li> <li>• The study is still going however preliminary results show that are no indications that children younger than 12 years old were the first in the family to be infected.</li> <li>• Children who were found to be infected with COVID-19 were less likely to have symptoms than adults.</li> </ul> |

## Appendix

### PubMed search terms

PubMed 1: (children) AND ((2019-nCoV[title/abstract] or nCoV\*[title/abstract] or covid-19[title/abstract] or covid19[title/abstract] OR "covid 19"[title/abstract] OR "coronavirus"[MeSH Terms] OR "coronavirus"[title/abstract] OR sars-cov-2[title/abstract] OR "severe acute respiratory syndrome coronavirus 2"[Supplementary Concept]) AND (2019:2020[pdat]) AND (attack rate OR index))

PubMed 2: (children) AND ((2019-nCoV[title/abstract] or nCoV\*[title/abstract] or covid-19[title/abstract] or covid19[title/abstract] OR "covid 19"[title/abstract] OR "coronavirus"[MeSH Terms] OR "coronavirus"[title/abstract] OR sars-cov-2[title/abstract] OR "severe acute respiratory syndrome coronavirus 2"[Supplementary Concept]) AND (2019:2020[pdat]) AND (transmission OR infectivity))

Filters applied: Systematic reviews

### Google search terms

Google 1: Infectivity of children COVID-19

Google 2: Index case children COVID-19

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