

# memo

## COVID-19-EPIDEMIC :

The role of children in the  
transmission of SARS-CoV-2  
(COVID-19)  
– a rapid review

**Title** The role of children in the transmission of SARS-CoV-2 (COVID-19) – a rapid review

**Institution** Folkehelseinstituttet/Norwegian Institute of Public Health

**Responsible** Camilla Stoltenberg, Director-General

**Author** Atle Fretheim, *Research Director, Norwegian Institute of Public Health*

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# Key messages

The findings in this memo are based on rapid searches in the PubMed-database. A single researcher has gone through the search hits, selected, critically assessed, and summarised the study findings. We opted for this approach despite an inherent risk of overlooking key evidence or making misguided judgements, due to the urgency of identifying research findings relevant to the following questions.

## ***Does SARS-CoV-2 infect children?***

The SARS-CoV-2 has been detected in many children, also in Norway, so there is no doubt that also children are infected. So far, children seem less prone to infection than adults are.

## ***Do they become ill?***

Reports from China and South Korea document that infected children may fall ill from the virus, and display typical signs of COVID-19 such as fever and airway symptoms.

## ***Are children as affected as adults are?***

Reports from China strongly suggest that children with COVID-19 in general experience milder symptoms than adults do, and there are very few registered deaths among children. Also relatively few children need intensive care.

## ***Do children transmit the virus? If so, to whom? Their parents? Other children?***

We have found five documented cases of likely spread of disease from children, but as the evidence is sparse, it is too early to say if children may play an important role in the spread of the disease, or not.

## ***What are the measurable effects of school-/nursery-closures that have taken place during the COVID-19 epidemic?***

We have not identified any data on this.

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# Contents

<b>KEY MESSAGES</b>	<b>2</b>
<b>CONTENTS</b>	<b>3</b>
<b>PROBLEM STATEMENT</b>	<b>4</b>
<b>METHOD</b>	<b>5</b>
<b>RESULTS</b>	<b>6</b>
<b>LIST OF REFERENCES</b>	<b>11</b>
<b>APPENDIX</b>	<b>12</b>

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# Problem statement

In connection with the Norwegian Institute of Public Health's (NIPH's) handling of the COVID-19 outbreak, we were asked to prepare a quick summary of available research on the following issues:

- Are children being infected by the virus? Do they become ill? Are they as severely affected as adults?
- Do children transmit the infection? If so, to whom? Their parents? Other children?
- What are the measurable effects of school closures/kindergarten closures that have been implemented during the COVID-19 epidemic?

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# Method

We carried out searches for published review articles and other research reports based on real data - not modelling studies. We only looked for studies with data from the COVID-19 epidemic. We conducted a series of searches in the PubMed database (see attachment).

Only one person (research director, Atle Fretheim) made the selection, assessment and summary of the evidence included in this rapid review.

Research librarian Elisabet Hafstad assisted with literature searches. Kjetil Brurberg (researcher, NIPH), Elisabet Hafstad (librarian, NIPH), Frode Forland (research director, NIPH) and Are Stuwitz Berg (chief physician, NIPH) reviewed this rapid review before publication.

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# Results

We found two review articles (1, 2) and ten research articles (primary research) (3-12) which we considered to be suitable for shedding more light on these issues. None of the two review articles met the usual criteria for systematic reviews, but they contained, among other things, statistics that we considered to be relevant. We did not do a formal quality assessment of the ten research articles, but primarily reproduce what the authors report.

## **Are children being infected by the virus?**

There is no doubt that the SARS-CoV-2 can be transmitted to children and that they can be infected. As of 22 March 2020, the Norwegian Institute of Public Health reported that 16 people aged 0 to 10 years and 70 people aged 11 to 20 had tested positive. However, this represents only a relatively small proportion of all registered cases testing positive (4.0%) (13).

Even though Norway is still at an early stage with the situation still unfolding, the low proportion of children correlates well with the data reported from China. Cao et al. reported nationwide numbers, excluding the Hubei province, until 10 February: "a total of 398 confirmed pediatric cases and 10,924 adult cases", meaning 3.6% of the COVID-19 cases were children (1). In addition, they reported that among 44,672 positive tests from across China, 416 were from children under 10 years of age, and 549 from the age group 10 to 20 years, which combined accounted for 2% of all positive tests. Lee et al. in his commentary article referred to the same Chinese statistics: "Recent data reported from the Chinese Centres for Disease Control and Prevention indicated that among the 44,672 confirmed cases of COVID-19 as of February 11, 2020, 416 (0.9%) were aged 0–10 years and 549 (1.2%) aged 10–19 years" (2).

An article from South Korea reported the age distribution for confirmed COVID-19 cases in the country until 2 March (4): Of the 4212 registered cases, 221 were younger than 20 years old (5.2%).

These results do not necessarily mean that children have a lower rate of infection than adults have, for the number of positive tests depends on how many tests are performed in total. If adults become ill from the virus more often than children do, it will lead to more adults being tested, and this most likely also contributes to finding a greater number of positive tests among adults. Nevertheless, the data from China

and South Korea are consistent with Norwegian data: far fewer confirmed cases of infection are registered among children than among adults.

### **Do children get ill, and are they as severely affected as adults?**

Chinese researchers recently published a report on children infected with COVID-19 in China based on data reported until 8 February this year (3). This is probably the most comprehensive data published until now which specifically look at the severity of the disease among children with COVID-19. The analyses are based on all 2,143 paediatric cases (the age group was not further specified) of COVID-19 reported to Chinese health authorities in the period 16 January to 8 February. One-third of these children (741) had tested positive for the virus, while the remainder were "suspected cases" based on clinical criteria.

The authors operate with five severity levels, with level 4 and 5 ("severe" and "critical") implying such serious illness that patients experienced breathing difficulties. Of all 2,143 children, 5.9% were classified as "severe" or "critical", which the authors point out is a much lower number than the corresponding rate for adults (18.5%). There was only one death among these children.

There were higher rates of serious cases among those who had received the COVID-19 diagnosis based on clinical criteria without a test than among the patients that had tested positive. This could mean that some of the seriously ill children may actually have suffered from a different respiratory infection than COVID-19, and the proportion with severe illness can therefore be somewhat lower than estimated. On the other hand, many of the children were still hospitalized, so we do not know the final results for all of them.

It may seem that the smallest children are more severely affected: The proportion of serious cases was 10.6% among children under the age of 1, 7.3% among the age group 1 to 5, 4.2% among those aged 6 to 10, 4.1% among those aged 11 to 15, and 3.0% among those aged 16 or older. These figures are uncertain, especially for the smallest children where a large percentage (71%) were diagnosed without testing.

Also worth noting: 13% of the children testing positive were reported to be without symptoms.

Lu et al. has published a similar report, limited to children in Wuhan who were younger than 16 years of age and who were registered as having a positive test result in the period 28 January to 26 February (and followed until 8 March) (5). These amounted to a total of 171 children. Only three of them needed intensive care, and all three had underlying disease (hydronephrosis, leukaemia and intestinal invagination). One of the three children died. Twentyseven of the 171 children (15.8%) had no symptoms or radiological signs of pneumonia.



In a report from South Korea, the severity among infected children is referred to in the following way: “Most pediatric patients are in mild clinical conditions” (4). There were a total of 22 deaths among COVID-19 patients by 2 March in South Korea. The youngest of them was 35 years old.

All in all, these figures suggest that the vast majority of children infected by SARS-CoV-2 experience mild or moderately serious illness, or no symptoms at all, but that some children may also be severely affected.

### **Do children transmit the infection? If so, to whom? Their parents? Other children?**

Cao et al.'s review article discusses the possible role that children play in the spread of the SARS-CoV-2 (1). They speculate that the transmission of the disease among children is one of several factors driving the epidemic, but they do not refer to any data supporting this (except for one case where an infant might have infected their parents – the same case that is discussed further down). They argue that the exponential increase in infection rates among children that took place in parallel with the exponential increase in infection among adults, supports their understanding of patterns of infection, in which transmission of the virus between children is one possible factor.

It is difficult to demonstrate with certainty how the virus has been transmitted in populations, but some studies have been published in which they have tried to trace the infection, and some of these also involve children. We have found seven such research articles.

Cai et al. (6): The authors reported the clinical picture of the first 10 children with a registered COVID-19 infection in Beijing. It is suspected that one of the children, an infant, may have infected the parents.

Park et al. (7): Provides a description of the probable route of infection for the first child registered to have been infected with COVID-19 in South Korea. The child was probably infected by an adult family member. There is no evidence that the child infected others.

Hu et al. (8): A review of 24 cases of people testing positive without symptoms in a province in China, who were identified through tracing close contacts of confirmed COVID-19 cases. Among these were six children. The authors believe they have detected one case of virus transmission from these 24, where a 67-year-old man is believed to have infected a family member. It is unclear how many close contacts were tested, so the article tells us nothing about the occurrence of people testing positive without presenting symptoms.

Ji et al. (9): In this report they described two Chinese families with children, where several family members had been infected by the COVID-19 virus. From what the authors reported, there does not appear to be any indications that the children had been the source of infection.

Wang et al. (10): The authors reported on possible infection routes among 31 children from six provinces in China who had tested positive for the virus. They conclude that family members probably infected 28 of them: “Nine cases (29%) were imported cases. [The] other 21 cases (68%) had contact with confirmed infected adults. One case (3%) had contact with asymptomatic returnees from Wuhan. Among the 31 children, 28 patients (90%) were family cluster cases.”

Chan et al (11): This article described a family of six persons, including two children. Five of the family members tested positive – only one of the children avoided being infected. The article reported nothing about the role of the child, or other children, in the spread of the infection.

Pung et al. (12): This report described three clusters of infected cases, all of which were comprised of only adults with the exception of one infant in one of the clusters. The article told us little or nothing about the chain of infection.

As far as we can see, very few, if any, reported cases of virus transmission from children have been published, but the material is too scarce to be used as a basis for a more general conclusion. It is also possible that viral transmission from children is lower in China than in other countries because the number of children per family is lower than in the rest of the world, due to the country’s one- and two-child-policies. We have not found any reports of outbreaks in schools.

In Iceland, which has the highest rate of testing per capita in the world, 10-15% of the patients tested have tested positive, but of the 268 tested children under the age of 10, only three tested positive for the virus (1.1%) (personal communication with Thorolfur Gudnason on 23 March 2020). Icelanders have also carried out testing among the population, with about 1% of those tested showing a positive result. This data includes 433 children, none of whom tested positive, which is interpreted as an indication that the transmission among children is very low (personal communication with Thorolfur Gudnason on 23 March 2020).

The tracing of infection routes in Norway has identified four probable cases of the virus being transmitted by children. All four are aged between 12 and 15. The other 406 known sources of infection in Norway are all adults (internal memo, NIPH).

Based on the current evidence, it appears that infected children do not represent a major vector for transmission, but it is too early to draw any conclusions yet as the picture may change as we get more comprehensive data from infection tracking processes.

### **What are the measurable effects of the school/kindergarten closures during the COVID-19 epidemic?**

We have not found any research reports that have calculated the effects of school/kindergarten closures during the COVID-19 epidemic. There are a number of systematic reviews on this issue, but they are mostly based only on studies done in connection with influenza epidemics. It is highly uncertain how relevant the experiences from influenza epidemics are in connection with the COVID-19 epidemic, as it is quite possible that children play a small role in the transmission of the SARS-CoV-2, as opposed to what is the case with the influenza virus.

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# Appendix

## Search strategies

### ***PubMed, main search:***

(((((Coronavirus[mh] OR "Coronavirus Infections"[mh] OR "corona virus"[tw] OR coronavirus[tw] OR coronovirus[tw]) AND (novel[tw]OR 2019[tw] OR Wuhan[tw])) OR "COVID-19"[tw] OR COVID19[tw] OR CORVID-19[tw] OR CORVID19 OR nCoV[tw] OR "SARS-CoV-2"[tw] OR "SARS-CoV2"[tw] OR SARSCoV19[tw] OR HCoV-19[tw] OR WN-CoV[tw]) AND (Infant[mh] OR Child[mh] OR Adolescent[mh] OR neonate\*[tw] OR infant\*[tw] OR child\*[tw] toddler\*[tw] OR kindergartener\*[tw] OR preschooler\*[tw] OR pre-schooler\*[tw] OR schooler\*[tw] OR schoolchild\*[tw] OR adolescen\*[tw] OR teen\*[tw] OR youth[tw] OR sibling\*[tw] OR pupil\*[tw] OR juvenil\*[tw] OR pediatric\*[tw] OR paediatric\*[tw]))))

Limited to publications from 2019–2020

(47 hits)

### ***Supplementary searches in PubMed***

LitCovid search on "children" under the "Transmission" tab. (44 hits)

Regular PubMed search on "School Covid-19 transmission" (122 hits)

