NIPH
Norwegian Institute of Public Health

memo

COVID-19-EPIDEMIC :

The role of children in the transmission of SARS-CoV-2 (COVID-19), 1st update – a rapid review

Title	The role of children in the transmission of SARS-CoV-2 (COVID-19), 1st update
Norwegian title	Barns rolle i spredning av SARS-CoV-2 (Covid 19), 1. oppdatering
Institution	Norwegian Institute of Public Health
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ISBN	978-82-8406-089-7
Memo	30. April – 2020
Publication type	Rapid review, COVID-19 rapid response
Number of pages	16
Commisioner	Norwegain Institute of Public Health
Citation	Brurberg KG. The role of children in transmission of SARS-CoV-2 (COVID-19), 1st update. Rapid review 2020. Oslo: Norwegian Institute of Public Health, 2020.

Key messages

The findings in this memo are based on rapid searches. One researcher has screened all records from the search, selected and summarised the study findings. We opted for this rapid 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.

Are children infected with SARS-CoV-2?

The SARS-CoV-2 has been detected in many children. There is no doubt that also children are infected, but children seem less prone to infection than adults.

Do children with COVID-19 become sick?

Children may fall ill from the virus, and typically display symptoms such as fever and airway symptoms. Available data strongly suggest that children with COVID-19 experience milder symptoms than adults, but evidence regarding children in different age groups is more uncertain. Critical illness and deaths are rarely observed among children.

Can children transmit the virus, and if so, to whom?

Current evidence suggest that children can transmit SARS-CoV-2, but there is no evidence that children are key drivers of transmission. Evidence is sparse, and it is too early to conclude firmly about the role children play in transmission of SARS-CoV-2.

What are the measurable effects of school closures?

We have not identified directly applicable data, but limited evidence based on experiences from the SARS outbreak in Bejing in 2003 suggest that school closure had limited impact on transmission control.

Hovedfunn (Norwegian)

Funnene i dette notatet baserer seg på raske søk. Én forsker har gått gjennom søketreff, og har valgt ut og oppsummert resultatene. Ettersom det har vært viktig å få fram forskningsresultatene raskt, har vi valgt denne raske framgangsmåten, selv om den innebærer risiko for at vi kan ha oversett viktig dokumentasjon, og at vi kan ha gjort feilvurderinger underveis.

Blir barn smittet av SARS-CoV-2?

Det er påvist smitte hos barn, også i Norge. Det er dermed ingen tvil om at barn kan smittes, men så langt ser det ut til at barn er mindre utsatt for smitte enn voksne.

Blir barn syke ved COVID-19?

Barn kan bli syke ved covid-19, og de kan typisk få feber og luftveissymptomer. Det finnes dokumentasjon for at barn med covid-19 opplever mildere symptomer enn voksne, men det er fortsatt uklart om covid-19 kan arte seg forskjellig for barn og unge i ulike aldergrupper. Kritisk sykdom og død rapporteres sjelden blant barn.

Sprer barn smitte, og i så fall til hvem?

Det finnes dokumentasjon for sannsynlig smitte fra barn, men det foreligger ikke dokumentasjon som tyder på barn har en sentral rolle i smittespredningen. Forskningen er imidlertid usikker, og vi kan ikke konkludere sikkert rundt barns rolle i overføring av SARS-CoV-2.

Hva er de målbare effektene av skolestengning?

Vi har ikke identifisert forskning som måler effekten av skolestengning direkte, men forskning basert på data som ble samlet i forbindelse med SARS-utbruddet i Bejing i 2003 antyder at skolestenging hadde begrenset effekt på smittespredningen i samfunnet.

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Vedlegg **Feil! Bokmerke er ikke definert.**

Introduction

In connection with the ongoing COVID-19 outbreak, it is important to gather information about virus transmission among children. The outbreak team at the Norwegian Institute of Public Health has asked us to update a rapid review about the role of children in the transmission of SARS-CoV-2, published March 23th 2020

Methods

Questions of interest

The questions of interest were the same as in the original version of this review, and can be categorised into four subdomains.

Regarding the risk of SARS-CoV-2 transmission:

- Are children infected?
- Do children with COVID-19 become sick?
- Do children transmit SARS-CoV-2 to others?
- What are the measurable effects of school closure or re-openings?

Searches

Information specialist Elisabet Hafstad conducted a search in the EndNote-database of the Norwegian Institute of Public Health's systematic and living map on COVID-19 evidence, combining terms for children (e.g. adolescen, child, infant and school) and terms for transmission (e.g. transmit, spread, shed, propag).

The EndNote-database was last updated April 22nd by searching the April 21th version of the Stephen B. Thacker CDC Library's collection of COVID-19 research articles. By April 22, our EndNote-database contained a total of about 12000 references. The Centers for Disease Control and Prevention (CDC) search a wide range of databases, PubMed, Embase, ClinicalTrials, bioRxiv, medRxiv among others, with the aim to be as "comprehensive, exhaustive, and systematic as possible". The methods used are detailed on their website[1].

We also ran a supplementary search in the LitCovid-database, using the search string "children" and "transmission".

[1] https://www.cdc.gov/library/researchguides/2019novelcoronavirus/researcharticles.html

Study selection

We have included reviews and primary studies answering the questions mentioned above. We excluded theoretical modelling studies, and studies investigating the risk of vertical transmission during pregnancy.

One researcher screened all records from the search, selected and summarised the study findings. Due to time constraints, we were not able to formally assess the quality of included studies or the quality of the evidence.

Peer review

Andreas Jansen (Head of the Information Centre for International Health Protection, Robert Koch Institute), Atle Fretheim (Research Director, Norwegian Institute of Public Health), Margrethe Greve-Isdahl (Chief Medical Officer, Norwegian Institute of Public Health) and Sara Sofie Viksmoen Watle (Chief Medical Officer, Norwegian Institute of Public Health), briefly reviewed the draft before publications.

When preparing this review we have chosen a very rapid approach as it has been imperative to obtain the research results quickly, even though it is associated with a certain risk of overlooking important publications and making errors.

Results

We included two reviews (1, 2) and ten primary studies (3-12) in the original version of this review (13). In this update we include additional references to answer the four main questions.

Are children infected?

SARS-CoV-2 can be transmitted to children. The Norwegian Institute for Public Health has received reports on 101 confirmed COVID-19 cases among children between 0-9 years, and 364 cases in the 10-19 age group. As by the end of April, the number of confirmed COVID-19 cases among people below 20 years constitute 6% of all confirmed cases in Norway (14) as compared to 5% in Denmark (15). Nor Sweden reports outbreak among children or adolescents[2].

A study from South Korea shows similar results as seen in Norway, as 221 of 4212 (5%) confirmed were younger than 20 years old (4). Data from China suggests people below 19 years constitute about 2% of the total number of confirmed cases (1, 16). Looking at the risk of being infected through close contacts, available data is inconsistent – one study suggest children are at similar risk as adults (17) whereas another study (18) suggests the risk of being infected by a close contact is far lower among children (4%) than for adults (17%).

Data from different countries consistently show that children and adolescents constitute a relatively low proportion of the confirmed cases. The most thorough study to date is from Iceland where the authors performed targeted testing (i.e. testing based on symptoms or contact history) and population screening to reveal COVID-19 cases (19). Whereas 38 of 564 (6.7%) children below 10 years tested positive following targeted testing, none of the 848 children tested positive following population screening. The study suggests that the incidence of SARS-CoV-2 is lower among children below 10 years of age (19).

[2] https://experience.arcgis.com/experience/09f821667ce64bf7be6f9f87457ed9aa

Do children with SARS-CoV-2 become sick?

In the original version of this rapid review we included three primary studies, but the number of relevant studies has increased during the last five weeks. Our searches for literature identified one systematic review (20) and six small case series (21-26).

A systematic review included seven case series of children with COVID-19 (20). The case series include 93 children between 3 months and 17 years, and the majority (98%) of the children had mild or moderate disease (20).

The most comprehensive study to date is the one by Dong and co-workers who investigated 2143 suspected COVID-19 cases among children (3). Of the reported cases, 741 had tested positive whereas the remaining diagnoses were based on clinical symptoms. More than 90% of the children were characterised as having asymptomatic, mild or moderate disease, 5% had severe disease and 0.6% had critical disease (3). Severe cases seem to occur more frequently among the youngest children, as the proportion of serious cases was 10.6% among children under 1 year, 7.3% among those 1 to 5 years, 4.2% among those 6 to 10 years, 4.1% among those 11 to 15 years old, and 3.0% among those older than 16 years (3). The latter figures are uncertain, especially for the youngest children where a large percentage were diagnosed without testing. Only 85 children under one year had confirmed SARS-CoV-2 infections, of which seven (8%) were severe (6%) or critical (2%) cases. For other age groups the proportions of severe or critical cases were 2% (1-5 years), 1% (6-10 years), 1% (11-15 years) and 5% (>15 years) when only children with confirmed infection were included (3).

Table 1 Severity of illness in children

First author Country Setting	**Patients**	**Results**
Dong et al (3) China	N=2143 Median 7 y Register	5.9 % severe or critical ill, as compared with 18,5 % among adults
Lu et al (5) China	N=171 <16 y In-hospital	Among 171 children with COVID-19 admitted to a hospital in Wuhan, three (1.8%) required intensive care, and all of them had underlying diseases.
KSID (4) South Korea		The authors state that most pediatric patients are in mild clinical conditions.
Chen (21) China	N=12 0.6-17 y In-hospital	Patients showed mild symptoms. Children infected with SARS-CoV-2 had different immune profile with higher T-cell amount and low inflammatory factors level compared to adults
Du (22) China	N=14 Median 6.2 y In-hospital	All pediatric patients mild or moderate disease. Asymptomatic patients (n=8) were younger than symptomatic patients (n=6)
Han (23) China	N=7 0.2-13 y In-hospital	All pediatric patients had mild disease. Mild disease more frequent in children than in adults.
Qiu (24) China	36 children 3.5-16 y In-hospital	Only mild (n=17) or moderate (n=19) cases
Wu (25) China	74 children Mean 6 y In-hospital	One patient with severe pneumonia required noninvasive ventilation, whereas the remaining were asymptomatic (n=20) or mild/moderate (n=53) disease.
CDC (26) US	123 children 0-19 y Register	123 cases per March 16, 2020. About 2 % in need of hospitalisation. No critical cases or deaths.

Do children transmit SARS-CoV-2 to others?

It is challenging to document how viruses transmit between humans, but studies tracing the spread within clusters of COVID-19 may shed some light. In the first version of this review, we included seven studies of this kind (6-12), and in this update we identified a few more such studies (17, 27, 28). Most studies of transmission within COVID-19 clusters describe transmission to children from adults, but transmission from children to adults is suspected in at least two cases (6). On the other hand, a study of a cluster in the French Alps reports on a symptomatic child with COVID-19 who attended three schools without transmitting the virus to any of the 172 contacts of which 84 were considered high/moderate risk contacts (27). Chan et al (11) describe a family of four adults and two children where the only one who avoided being infected was one of the children.

Per 23.03.2020 har FHI blitt informert om 562 tilfeller som sannsynligvis har blitt smittet gjennom nærkontakt til et kjent covid-19 tilfelle, av disse har FHI mottatt konkret informasjon for 371 om hvem de sannsynligvis har blitt smittet av. Av disse utgjør barn en svært liten andel.

In a narrative review by Choi and co-workers (29), the authors conclude that children usually are diagnosed with COVID-19 following exposure to closely related infected adults, and that transmission from children probably occur less frequently. Based on the available documentation, it appears that infected children do not constitute a major source of infection, but we need more comprehensive data before we can draw certain conclusions.

What are the measurable effects of school closure?

We identified one rapid systematic review that looked into school closure and management practices during the COVID-19 outbreak (30). The authors included 16 publications, but none of the included studies measured or reported the isolated effect of school closure on limiting the transmission of COVID-19. Two studies performed in Bejing during the SARS outbreak in 2003 suggest that school closure had very limited impact on transmission control (30).

The authors cite a modelling study by Ferguson and colleagues that is not peer-reviewed, but that is the only available study looking into the isolated effect of school closure (30). The model was based on population data from UK, SARS-CoV-2 transmission dynamics reported in Wuhan, and data from previous influenza outbreaks. The authors conclude that school closure is insufficient to control the COVID-19

pandemic, and that school closure during the outbreak can potentially reduce the total number of deaths by 2-4% (30).

A recent report published by the National Centre for Immunisation Research (NCIRS) and Surveillance in Australia (31) confirms the conclusion in the findings above. NCIRS investigated transmission of SARS-CoV-2 in ten high schools and five primary schools in which 19 COVID-19 cases were identified between March 5th and April 3rd. The eight initial cases had close contact with 863 people within the schools, and only two secondary cases were identified (31). NCIRS concludes that SARS-CoV-2 transmission between school children appears to be considerably lower than for other respiratory viruses, and that children are probably not key drivers of SARS-CoV-2 transmission (31).

Discussion and conclusion

COVID-19 seems to occur less frequently among children than among adults. The relatively low number of confirmed cases among children may reflect that children are tested infrequently because they show milder symptoms, but a population screening study from Iceland confirms the general picture from other studies, that fewer children than adults are infected (19). The reasons why children are less prone to COVID-19 than adults are unclear, but it has been suggested that the differences can be related to the immune response, co-infections or differences in the expression of ACE-2 receptors (32).

Several recent publications were identified and included in this updated review, but the conclusions remain similar as in the original review. Even though many studies on transmission among children report a small number of cases, children do not seem to contribute substantially to the transmission of SARS-CoV-2. However, we need more large and well-conducted studies in order to draw more firm conclusions.

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Published by the Norwegian Institute of Public Health
April 2020
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