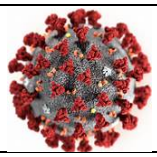
National COVID-19 Science Task Force (NCS-TF)



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Title: The role of children in the transmission of Sars-Cov2

Executive summary: The role of children and adolescents in the transmission of Sars-Cov2 remains highly uncertain. This has important consequences on policy decisions, in particular in relation to the opening of schools, sports activities and to intergenerational contacts. It is argued that, in the face of this uncertainty and in view of the public sensitivity of policies related to children, a precautionary principle should be applied and clearly communicated in policy-making. Furthermore, there is urgent need for a longitudinal study that addresses the role of children[1] in Sars-Cov2 transmission, to enhance the safety and effectiveness of policies relating to children.

[1] *This policy briefs focuses on children, defined here as <10 years of age.*

Preamble

It is well known that COVID-19 disproportionately affects the older adult population and elderly and has mostly mild effects on children and adolescents, even if these do get infected. The reasons of this relatively mild effect on children remain so far largely unknown[2]. However, and importantly, ***absence or mildness of symptoms does not imply lack of transmission***. This is evidenced by the now well-known fact that a significant proportion of transmissions are due to asymptomatic and mildly symptomatic individuals. This fact raises the possibility that children rarely develop overt disease, but may still transmit the virus, which has direct effects on the role of children in society, with two main cases being (i) schools, where the strong social mixing component could enhance the spread of the virus in society if children transmit, and (ii) children-grandparent relations, where social distancing is strictly required if children transmit.

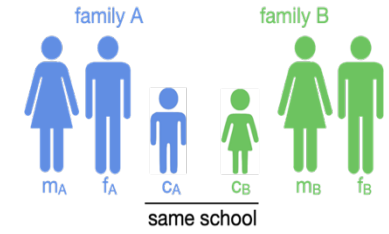

Figure 1 | *A possible transmission chain involving children in a school setting. The schematic depicts two families A and B. The two children – $cA_{,}$ and $cB_{,}$ – are in the same school and in the same class. If children can be vectors, this provides a possible transmission chain from a parent in family A to a parent in family B through the two children. The probability of this transmission chain is currently unknown.*

[1] *This policy briefs focuses on children, defined here as < 10 years of age.*

[2] *Possible reasons include (i) the maturity and function of ACE2 in children being lower than in adults, (ii) children often experiencing respiratory infections (e.g., respiratory syncytial virus) in winter and thus possibly having higher levels of antibodies against the virus than adults; (iii) children's immune systems responding to pathogens differently from adult immune systems due to their still-developing status; and (iv) children having less developed immunity hence also immunopathology. See for example Dong et al. (2020).*

The central question thus is: ***do children transmit the Sars-Cov2[3] virus?*** For influenza, it is well known that children are a main driver for the dissemination of the virus (Cao et al. 2020). For COVID-19, instead, ***current evidence is insufficient to conclusively answer this question***, with information tending to show that children are not the main driver of the epidemic but are involved in the transmission. It is therefore currently incorrect to assume that children do not transmit the Sars-Cov2 virus. This creates a "decision under uncertainty" situation when devising policies related to children, and highlights the urgency of obtaining robust evidence.

Evidence

The literature is scarce and reports mainly case studies that are investigations among very few individuals/small population groups. Some case studies claim that children play a role in the transmission dynamics, yet this evidence is either indirect or questionable. According to Cao et al. (2020), Cai et al. (2020) allegedly report "what is probably the first evidence indicating children as a source of adult infection". However, a check on the original source (in Chinese) does not confirm this conclusion. Analyzing the epidemic in China and based on indirect evidence only, Cao et al. (2020) state that the "accumulated cases from adult and pediatric populations strongly supports the transmission dynamics of pediatric patients", namely the potential spread within schools as a connector among community nuclei (e.g., families; see figure above). In contrast, analysis of family clusters indicate that children were infected by adults first and not by children that brought the infection into the family from outside/schools (Qian et al. 2020, Danis et al. 2020, Qiu et al. 2020, Li et al. 2020b, Su et al. 2020).

Several reviews highlight the "possibility that children could be facilitators of viral transmission", precisely because "children are susceptible to SARS-CoV-2 infection, but frequently do not have notable disease" (Kelvin and Halperin 2020). The US Center for Disease Control and Prevention (CDC) also states that "children are likely playing a role in transmission and spread of COVID-19 in the community" (CDC COVID-19 Prevention Team, 2020). The German Academy of Sciences Leopoldina works on the basis that children can transmit the infection (Leopoldina, 2020).

Most other papers emphasize the lack of direct evidence that children can transmit. While recognizing that "children as asymptomatic or mildly symptomatic carriers of the virus may transmit the virus to other groups (elderly relatives, caregivers, etc.)", Morand et al. (2020) find that "no transmission of the Sars-Cov2 virus from children to adults has been described to date".

Danis et al. (2020) describe a pediatric patient who was infected while on holidays in France and despite him being symptomatic did not infect even close contacts while visiting three schools when coming back to the UK, potentially inferring a lower infectiousness for children than for adults. While there are reports describing asymptomatic or presymptomatic patients being infectious, further studies specifically targeting the infectiousness of children are missing.

There is however evidence (albeit scarce) that children do not get infected by Sars-Cov2 as easily as adults. Li et al. (2020b) present a case where a family member infected all of his close relatives but a child (aged 7 years), who stayed asymptomatic and was tested negative for COVID-19. A cohort study by Li et al. (2020a) calculated a much lower secondary attack rate (SAR) for children (n = 4) than for adults (4% vs. 17.1%), meaning that their risk of

[3] *COVID-19 is the disease, Sars-Cov2 is the virus that causes it.*

getting infected was lower than for adults. It is particularly interesting that the risk for smaller children (aged 0-5 years) was lower than for older children (aged 6-17 years) (SAR: 2.3% vs. 5.4%, respectively).

The hypothesis that children are less prone to infection by Sars-Cov2 is supported by Jing et al. (2020), who analyzed 195 clusters from the epidemic in China and found that the probability of infection among children (<20 years old) was 0.26 times the probability of infection among the elderly (> 60 years old). While this is a substantial reduction in probability, it must also be considered that the number of contacts among children – especially in schools – is considerably higher than among the elderly (e.g., Ferguson et al (2020) assumed the per-capita contacts within schools to be double those elsewhere), partially offsetting their reduced probability of infection.

A population-based study in Iceland by Gudbjartsson et al. (2020) also showed that children (<10 years old) were infected with Sars-Cov2 less often than individuals >10 years old. This was the case not only for the general population but also for higher-risk individuals (symptomatic, returning travelers from high-risk areas or contacts of infected people).

With only inconclusive evidence about asymptomatic children's possibility to transmit Sars-Cov2, Dong et al. (2020) showed that only 1.9-6.5% of them are completely asymptomatic, with the highest rate of asymptomatic patients in the 11-15 year age bracket and the lowest rate in the <1 year olds. While a part of them is thus still asymptomatic or only mildly symptomatic, children are not silent virus spreaders as a majority of them is still symptomatic. This is supported by a review by Choi et al. (2020), which shows that a minority of the infected children is asymptomatic (0-12%), while a majority has at least symptoms of an upper respiratory tract infection (20-65%) or a mild pneumonia (26-80%).

There is evidence that even asymptomatic children or children who no longer test positive for Sars-Cov2 in the nasopharyngeal swabs shed Sars-Cov2 in their stool for approximately 10 days (Xu et al. 2020, Zhang et al. 2020).

While most children are usually only mildly sick (Ludvigsson et al. 2020, Morand et al. 2020, Lu et al. 2020), <1 year olds have the highest rate of severe or critical disease (10.6% vs. 7.3% for 1-5 year olds) (Dong et al. 2020). This is supported by a CDC report highlighting that the worse disease progression in children occurs in <1 year olds (CDC COVID-19 Prevention Team, 2020).

In a modeling study that was not peer-reviewed, but frequently cited, Ferguson et al (2020) compare different non-pharmaceutical interventions, finding that school closures alone would reduce total deaths by 2-4% and peak ICU bed demand by 14-21%. However, their modeling results apply for a high reproductive number R_0 of 2.2 and 2.4 and suggest that for a lower reproductive number of 1.0 or 0.6 (as is currently the case in Switzerland) school closure alone could reduce total deaths by 16-20%[4].

Davies et al. (2020) however showed in another mathematical model (also not yet peer-reviewed) that school closures only have a limited effect in transmission and control of the pandemic in countries like Italy or the United Kingdom if children are as susceptible to infection as adults (independently of the transmission rate of asymptomatic patients). The effect is higher in countries with a higher proportion of children (like Zimbabwe).

Viner et al. (2020) saw no impact of school closures on transmission control during the coronavirus epidemics with SARS and MERS. As school closures would only work if there is a high attack rate in children and if they have a high rate of transmitting the virus in schools

[4] This estimate is not contained in the paper by Ferguson et al, but obtained through a simple linear extrapolation of the reproductive number.

(no evidence for previous coronavirus outbreaks) and due to the immense socio-economic cost of closing schools, they propose a more gradual approach similar to Taiwan where schools are closed locally in case of an outbreak at school.

Based on the existing evidence, we therefore conclude that

1. Evidence of the ability of children to either transmit the Sars-Cov2 virus or not to transmit the Sars-Cov2 virus is currently very sparse. While it appears that children are not the main drivers of this epidemic, their role in transmission remains open and ***all the evidence is currently insufficiently robust***. Thus,
2. ***We currently cannot provide strong conclusions on whether children can or cannot transmit the Sars-Cov2 virus***,

   and we caution that

3. Absence of evidence is not evidence of absence: ***it cannot be assumed that children do not transmit the virus.***

Decision under uncertainty and the precautionary principle

The absence of conclusive evidence for the role of children in transmission, together with the importance of developing policies for schools and other children-related activities on rapid timescales, ***creates a situation of "decision under uncertainty". What is certain is that it remains scientifically incorrect at this point in time to assume that "children do not transmit".*** Instead, ***in the face of this uncertainty, we consider the adoption of a precautionary principle to be the appropriate stance, i.e.,*** we must accept the possibility that children may transmit the virus and adopt measures to minimize the consequences of this transmission.

A number of prominent organizations make use of the precautionary principle in this specific situation. The US Center for Disease Control and Prevention states that "social distancing and everyday preventive behaviors remain important for all age groups" (MMWR, 2020). The German Academy of Sciences (Leopoldina) takes the precautionary stance that children can transmit the virus, and based on this stance elaborates a number of conditions and measures for school re-openings (Leopoldina 2020).

Kelvin et al. (2020) conclude that "if children are important in viral transmission and amplification, social and public health policies (e.g., avoiding interaction with elderly people, teachers in risk group) could be established to slow transmission and protect vulnerable populations."

The question of whether and when to open schools under conditions of uncertainty is a conflict of values. All children have a right to free and *adequate* basic education that is *available to all children* (Art. 19 and 62 of the Constitution). Pre-primary and primary education in distance learning is not sustainable and negatively affects the equality of chances. The longer the epidemic is expected to last, the more important it becomes to enable the right to education to be implemented without waiting for complete safety to return. In order to decrease the moral cost of schools re-opening, measures aimed at diminishing transmission within schools will need to be implemented. Accommodations for high-risk students, students living with high risk family members, and high-risk school staff will also need to be devised, and may include the continuation of distance learning in some cases. All approaches that are adopted should ensure equal access for disabled and low-income students.

The explicit recognition that current evidence is inconclusive, and that the decision to reopen schools represents a conflict of values, as well as explanations of the reasons why the decision is made and of the precautions taken to protect vulnerable individuals, are all important for a transparent communication with the public and ultimately to ensure public acceptance of policy decisions. For example, it would be inconsistent to mandate social distance between children and the elderly (e.g., grandparents) if children actually do not transmit the virus. Instead, the recognition that they *might* transmit the virus fully justifies the need for social distancing between them and the elderly and high-risk persons. By the same token, the recognition that children *might* transmit the virus indicates that the reopening of schools and of other activities in which children congregate or interact with adults outside the family (mainly sport activities, music teaching) should be accompanied by hygiene and social distancing measures that minimize the spread. This was for example explicitly recognized by the Leopoldina (Leopoldina 2020), whose recommendations for school re-opening policies have been adopted in recently announced school-reopening measures in Germany.

As uncertainty is difficult to deal with, clarity should be the goal whenever possible. For example, there seems to be a crucial need to make and communicate decisions regarding exams and grading on all levels of education. Before the re-opening of schools, teachers, parents and students must be provided with all relevant information (including what is known and unknown regarding risks). The backlog in learning should be assessed as soon as possible – on the individual level and in general. There should be explicit planning on how to catch up (such as extra teaching, tutorials, etc.).

Policy measures for schools

Maintaining the usually recommended social distancing (> 2 m distance among individuals) in schools is challenging or nearly impossible, both due to the often-constrained spaces available and to the difficulty of children respecting social distances, particularly over extended periods of time. Therefore, school re-opening should be accompanied by substantial measures to minimize transmission and these measures should be clearly communicated to both school personnel and parents. Constant monitoring of transmission in schools and by children in particular should be the basis for subsequently relaxing these measures progressively.

Basic measures include these:

- Children with symptoms stay at home
- Children take the most direct way from home to school and back
- Children and teachers avoid use of public transportation where possible, carry masks when using it
- Parents minimize time spent on school premises and strictly adhere to hygiene and social distancing rules if at school

Additional social-distancing measures should be strongly considered. A non-exhaustive list includes these:

- Limit the number of children per class in schools (max 15)
- Limit the number of children per room in kitas (max 5)
- Reduce the number of hours of school per day or the number of days of school per week, focusing only on core subjects (e.g., main language, mathematics, natural sciences)

- Prevent mixing among classes during recess, for example by staggering the time of recess by grade or defining separate recess areas
- Cancel high-contact activities (e.g., team sports)
- Stagger lunch hours or allow children to go home for lunch, including in day schools
- Close or minimize participation of children in after-school settings (e.g., 'Hort')
- Continue home-schooling for an additional time period for higher grades like high schools, universities and higher education settings, i.e., reopen only kitas, kindergartens, primary schools and middle schools (the nine compulsory years).

It is also important to recognize that different schools need different solutions, depending on size, space, number of students, teacher population, transportation needs, etc. Schools must be allowed to handle normalization flexibly – splitting classes, adapting different teaching hours, breaks, etc. These plans should be submitted and controlled before they are implemented, and properly monitored at the cantonal level. Warning systems and complaint mechanisms should be established.

These measures should at all times be supplemented with ***strict hygiene measures*** with frequent hand washing mandated by the schools, complemented by

- compulsory equipping of schools with hand-disinfection stations,
- no physical contact among children,
- no handshaking with teachers,
- avoidance of close assemblages in school procedures (e.g. "Morgenkreis"),
- more frequent cleaning of school toilets.

It is imperative that all school personnel be thoroughly educated about the importance of social distancing and hygiene measures.

High-risk groups among teachers and caregivers (e.g., teachers above 65 years of age) should be particularly protected. The legal right for high-risk staff and students to remain at home must be clarified.

Accommodations for high-risk students, students living with high risk family members, and high-risk school staff will also need to be devised, and may include the continuation of distance learning in some cases.

Appendix 1 shows measures adopted by different countries in re-opening their schools.

The urgency of a dedicated testing program to complement re-opening of schools

The absence of conclusive evidence for the role of children in transmission further highlights the urgency of obtaining robust data on this matter. This is recognized both nationally and internationally (e.g., Kelvin et al. 2020; Lu et al. 2020; Fineberg 2020). Robustly determining the absence of a role of children in transmission will allow full school reopening, render social distancing measures in children less severe, and exclude that schools will negatively affect the reproductive number of the epidemic.

We thus urge that the re-opening of schools be accompanied by a real-time, rapid research protocol. This should involve repeat PCR and antibody testing among a sample of schoolchildren, teachers and other adult school employees to ascertain the presence of infection and the rate of acquisition of new infection among the children, and the monitoring of infection among the adults in closest contact with large groups of children. This approach could provide an early indication of spread of infection among and from schoolchildren.

Schools reopening will be subject to precise rules across countries

BASED ON PRESS SEARCH, AS OF APRIL 20, 2020

	Austria	Italy	France	Germany	Czech Republic	Spain	Denmark
Re-opening date	▪ May 4 – TBC by end of April	▪ UNDER DISCUSSION – likely September	▪ May 11– return to school would "not be mandatory" (*Blanquer, Ministry of National Education, April 14)*. Not specified yet whether the decision to send the children back to school would be up to the schools or parents (details expected to be defined by end of April)	▪ May 4 (Bavaria May 11) ▪ Government considers infection numbers every 14 days and reconsiders measures ▪ Individual states can deviate from federal policies	▪ April 20 – return to school "is by no means obligatory"..." parents will be able to put their children into school groups, which should make things easier for families" *(Robert Plaga, Educaiton Minister, April 15)*	▪ Not before summer (TBC)	▪ April 15
Order of gradual reopening	▪ Only students in the final year of high school can re-start school on May 4 ▪ Regular operations may resume by mid-May (TBC) ▪ University to remain closed for the remainder summer semester (TBC) ▪ Primary, lower secondary schools and kindergarten still open and can be attended by children whose parents are doing "indispensable" jobs	▪ HYPOTHESIS: Lessons with half students online and half face to face; additional classrooms to be established; some lessons open-air; use of government online platform (ALL TBC)	▪ The lycées professionnels (technical colleges) to open first, then the rest (TBC) ▪ University might re-open after summer (TBC)	▪ Priority given to final years of primary and secondary schools ▪ Daycare centers and kindergartens remain closed ▪ Kindergarten open only for children with parents having a system critical job (e.g. doctors) with strict rules	▪ April 20: Universities final-year students, only for specific purposes (e.g., consultations or individual examinations) ▪ May 11: final-year students at secondary school ▪ May 25: 1st-5th grades of elementary schools ▪ After summer: 6th -9th grades of elementary school and remaining secondary schools	▪ TBD	▪ Initially, only schools for students up to age 11 and day care/ kindergartens to re-open ▪ Older children (11-16 y.o.) to return to school at the earliest on May 10 ▪ University might re-open after summer (TBC) ▪ Some open air classes
Rules in classrooms	▪ Classes can start on May 5 only in small groups of 5	▪ TBD	▪ *Rules to be defined by end of April*	▪ NO RULES ANNOUNCED YET but suggested in detailed by Leopoldina study and expected to be announced by end of April	▪ For 1st-5th grades of elementary schools: 15 people max per class; groups remaining the same for all activities	▪ TBD	▪ Classes split in two, with one teacher for 10/11 students ▪ Lessons partially open air ▪ Children play only in subgroups of students from their class ▪ Shorter school day for some students
Social distance, hygiene rules and periodic disinfection of surfaces	To be applied in all countries (1.5 or 2 meters expected)			▪ By end of April, Ministers develop a concept for hygiene measures, school bus operation, recess times and class sizes			
Personal protections	▪ YES on masks for children >6 years old who continue going to school and their teachers – local administration is responsible to provide them with masks	▪ HYPOTHESIS: YES, maybe gloves as well (TBC)	▪ UNDER DISCUSSION – "very possibly" schools would get stocks of masks that they could distribute to pupils & teachers (*Blanquer, Ministry of National Education, April 14)*	▪ TBD - at the moment strongly recommended only in grocery shopping and public transport	▪ Masks are obligatory on school premises, but teachers decide whether they must be worn during class	▪ Not compulsory but recommended	▪ NO – Instead, social distance more rigorously imposed (2 meters between desks and one student per desk)
Rules for exams	▪ The final-leaving exams of high school (Matura) will take place on May 25 and only in written form ▪ Important exams will take place under certain restrictions	▪ HYPOTHESIS: everybody will likely pass the year ▪ No exams at the end of 8th year of school ("terza media") ▪ An only oral (possibly online) exam for Maturità enough for University acceptance[1]	▪ Students won't take the national end-of-high-school exam known as the Baccalaureat ▪ A jury will examine their academic transcript	▪ The Abitur exam is maintained ▪ Examinations for students about to graduate are possible also before beginning of May, under strict conditions	▪ All end-of-high-school exams are postponed (date to be announced at a later stage) ▪ High-school graduation and entry exams to be held after June 1	▪ Everybody will pass the year (with exceptions) ▪ No exams at the end of the year (evaluation based on performance in last 6 months) ▪ University exams in July confirmed for now	▪ All end-of-term exams in upper secondary school cancelled

1 https://www.ilmessaggero.it/scuola/covid_19_italia_scuole_ultime_notizie_promozione_maturita_esame_sei_politico-5149404.html; https://www.repubblica.it/scuola/2020/04/02/news/maturita_-252977713/?refresh_ce

SOURCES: Austria: https://metropole.at/coronavirus-in-austria/ Italy: https://www.corriere.it/testeri/cards/riapertura-lappe-11-paesi-chi-comincia-scuole-chi-prevede-mascherine/spagna.shtml; https://www.quotidiano.net/cronaca/coronavirus-scuole-1.5109971 ; https://www.corriere.it/scuola/primaria/cards/coronavirus-scuole-chiuse-francia-germania-spagna-l-europa-contropiede-riapriamo-adagio/scelte-altri_principale_preview.shtml?reason=unauthenticated&cat=1&cid=OWKWk700&pids=FR&credits=1&origin=https%3A%2F%2Fwww.corriere.it%2Fscuola%2Fprimaria%2Fcards%2Fcoronavirus-scuole-chiuse-francia-germania-spagna-l-europa-contropiede-riapriamo-adagio%2Fscelte-altri_principale.shtml&refresh_ce-cp Czech Republic https://brnodaily.com/2020/04/15/news/politics/czech-education-system-to-reopen-in-stages-after-covid-19-outbreak/; https://edition.cnn.com/2020/04/11/health/european-countries-reopening-coronavirus-intl/index.html Germany: https://edition.cnn.com/2020/04/11/health/european-countries-reopening-coronavirus-intl/index.html; https://www.dw.com/en/a-nitty-gritty-look-at-germanys-loosened-coronavirus-lockdown-rules/a-53149361; Spain https://english.elpais.com/society/2020-04-17/government-advisors-support-reopening-spanish -schools-in-september.html; Denmark:https://www.thelocal.dk/20200406/denmark-to-reopen-schools-and-kindergartens-next-week; https://www.ft.com/content/de2027d4-5153-462b-a38d-75b7a5ddad17 France:https://www.nytimes.com/aponline/2020/04/03/world/europe/ap-eu-virus-outbreak-europe-school-exams.html; https://www.thelocal.fr/20200414/lockdown-how-france-will-reopen-its-schools-after-may-11th

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