

Update (3 July 2020) on susceptibility and transmission of SARS-CoV-2 by children and adolescents:

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Our meta-analysis (<https://www.medrxiv.org/content/10.1101/2020.05.20.20108126v1>) included searches up to 16 May. We have updated our searches of PubMed and medRxiv to 3 July 2020.

Contact tracing studies

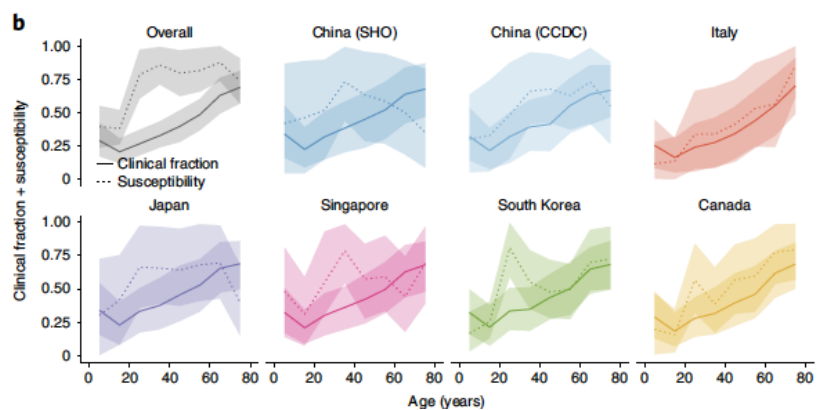
Our review in its previous version included 8 contact tracing studies. Three potential additional studies have been identified and may be included in a further meta-analysis.

Dattner <https://www.medrxiv.org/content/10.1101/2020.06.03.20121145v1.full.pdf> - undertook a contact tracing study in the city of Bnei Brak (250k population) in Israel – where 51% of the population under 20y. Identified all households in city where all household members had been PCR-tested and ≥ 1 member was positive. 637 households with $n=3353$ persons of whom 1510 were positive. Index cases within households were identified from test date and symptom onset; In total across all households, 512/1544 (33%) were positive 0-19y compared with 998/1809 (55%) of adults 20y+. Secondary attack rates increased with age: 15% <5y, 19% 5-9y, 30% 10-15y and 38% 15-19y – overall this was 25% in 0-19y compared with 44% of adults. Modelling estimated that 0-19y had a relative susceptibility of 45% (40,55) and relative infectivity of 85% (65, 110) compared with adults. Note 72% of 0-19y reported symptoms – suggesting potential bias.

Two other studies were similar to those originally included. Inclusion of these additional studies in a revised analyses is unlikely to change the original conclusion i.e. that the pooled odds of being an infected contact in children compared with adults was 0.44 (0.29, 0.69).

Note Davies, Eggo et al. is now published in Nature Med : fitted an age-structured mathematical model to epidemic data from China, Italy, Japan, Singapore, Canada and South Korea. Estimate that susceptibility to infection in individuals under 20 years of age is approximately half that of adults aged over 20 years, and that clinical symptoms manifest in 21% (95% credible interval: 12–31%) of infections in 10- to 19-year-olds.

<https://pubmed.ncbi.nlm.nih.gov/32546824/>



Transmission studies of children as index cases

One study was included in the previous analysis – a systematic review of household transmission studies (Zhu et al).

Van der Hoek et al. <https://www.ntvg.nl/artikelen/de-rol-van-kinderen-de-transmissie-van-sars-cov-2/volledig> - published data from a national Dutch study containing three sub-studies. The first was national surveillance data from municipal reporting that identified 732 infected (PCR) 'pairs' that lived in the same household up to 13 May. The vast majority of pairs were adults infected by other adults. Where children were one of the pair (23 pairs), children were infected by adults in 91% (21 pairs) and only infected by other children in 2 pairs (9%).[1]

The second element of Van der Hoek related to contact-tracing data up to 2 April from 23 of the 25 Dutch municipalities (GCDs). Only 10 cases were registered under age 18 and 0 of 43 close contacts developed COVID-19; this compared with a secondary attack rate of 8.3% (55/666) in close contacts of 221 adult cases.[1] Note secondary cases were identified through linkage to the main national surveillance database so this would suggest that only symptomatic secondary cases were included.

School and childcare setting studies

New data from the NSW schools study[2] will be available imminently (to update when available)

Desmet et al. used pre-existing surveillance to study the prevalence of SARS-CoV-2 in a random sample of nursery day centres in Belgium (n=8) between 2-12 March. Note first cases 4 Feb in Belgium; lockdown occurred 18 March. Found 0/85 positive on nasopharyngeal swab.

<https://www.medrxiv.org/content/10.1101/2020.05.13.20095190v1>

Heavey et al (<https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.21.2000903?emailalert=true>) Republic of Ireland national surveillance: all SARS-CoV-2 notifications were screened to identify all those <18y and all adults who attended school settings in period before schools were closed on March 12 2020. Positive cases = 3 children (1 primary school; 2 secondary) and 3 adult school staff. 2 of 3 children and all adults were symptomatic cases. Total school contacts identified = 1155 (1001 child contacts) – with contacts occurring before schools closed. Close contacts were under surveillance for 14 days. No secondary cases identified from child index cases. One adult secondary infection from the adults cases.[3] There are significant concerns with the low numbers in this study and that only symptomatic contacts were tested.

Fontanet et al (<https://www.medrxiv.org/content/10.1101/2020.06.25.20140178v2.full.pdf>) undertook a seroprevalence study in the 6 primary schools in the city of Crepy-en-Valois north of Paris where an outbreak had occurred in the city high school (leading to local lockdown from 1 March). All staff, students, parents and siblings >5y invited - 49% (510/1047) pupils and 82% (42/51) teachers participated plus 641 parents, 119 siblings and 28 other staff. Timing of testing not stated. Seropositivity was found in 8.8% of primary school children, 7.1% of teachers and 11.9% of all parents and 61% of parents of an infected pupil. 2 parents were hospitalised and none died.

Dutch data (Van der Hoek et al) from municipal public health service (GGDs) symptomatic testing show that virus prevalence in teachers and childcare workers from 1-25 June was 0.5% (n=14,000) compared with 1.3% across the total population tested. Note that positivity rate was 0.3% in 0-12 years and 1.4% in 13-18 year olds.[4]

Other data on schools and SARS-CoV-2

Outbreaks in schools do occur and have been reported in the media from a number of countries e.g. Israel. Yet the vast majority have involved tiny numbers, adults are the source of the outbreak in some,[5] and only one outbreak has been studied in detail. An outbreak study in a French high school near Paris found that around 40% of students and teachers developed antibody evidence of SARS-CoV-2 infection.[6] However only 26% of the students and teachers at the school participated, suggesting significant selection bias.

Impact of school openings on national epidemic metrics

Data from countries where schools have been open for some time show school opening has made no discernible difference to community transmission. In countries where early years and primary schools have reopened, Denmark (15 April), Finland (14 May), Norway (20-27 April)[7, 8] and the Netherlands (11 May), data to mid June show that cases of COVID-19 in the general population have fallen and the reproduction number (R) has stabilised or continued to fall.[9, 10] [11] In Denmark and Norway there have been no increases in infections in children and young people since schools reopened,[7, 8, 12] although we don't have data on the other countries.

RIVM Netherlands Institute of Public health reports: "After double-checking with all 25 municipal public health services (GGDs), it has become apparent that there were no reports of possible COVID-19 clusters that had a link to schools or childcare facilities (or temporary childcare) before the schools closed on 16 March. After reopening the primary schools and childcare facilities, a few reports have come in regarding infections among employees at schools; RIVM has not received any reports of employees who were infected by children (based on data as of early June 2020). The reproduction number R, which represents the average number of new infections by a COVID-19 patient, has fluctuated below 1 since mid-March. After the partial reopening of primary schools and childcare facilities on 11 May, there was no sudden increase in the reproduction number." [4]

There are no new published data from Iceland (where primary schools remained open) after the Gudbjartsson et al. paper, which showed no positive cases amongst under '10s [13] although this was relatively early in the pandemic.

UK data relevant to child care and schools

sKIDs (COVID-19 surveillance in school KIDs) study (<https://www.gov.uk/guidance/covid-19-paediatric-surveillance>)

Verbal report from Shamez Ladhani, PHE:

138 schools participating in the surveillance (approx. 9000 participants, staff and children)

- 89 are having weekly swabs (6,637 participants)
- 49 are having bloods and swabs at the beginning and end of the term (2,346 recruited)
- As of 28 June: 13,748 nasal (and some throat) swabs tested so far – with only 5 positive

Nurseries Many schools and nurseries have remained open to very small numbers of children during the lockdown, with around 10-20% of all pupils (Years Reception, 1 and 6) returning on 1 June 2020. A rapid survey of the 62 childcare nurseries attached to NHS hospitals in England was carried out by the Children's Commissioner for England in May 2020. All had been operating throughout lockdown, averaging 50% capacity for children and with around 85% of usual staff. Managers from 39 nurseries responded that they had witnessed no transmission of COVID-19 in the nurseries, and there was no known cases of staff acquiring infection from children.[14]

PHE respiratory outbreak data

Public Health England reports small numbers of infections in schools continue to occur in England; for example in the week 8-14 June (week 24), PHE received 24 reports that 2 or more individuals in a school had what appeared to be a similar respiratory infection but only 12 individuals tested positive for SARS-CoV-2.[15]

A recent spike in cases in Leicester showed rising cases amongst under 19s and middle-aged persons, however we are unaware of evidence of transmission within schools.[16]

Prevalence/ seroprevalence studies

National prevalence studies.

A. Virus prevalence

1. **Sweden:** report on national virus prevalence 21-24 April and 25-28 May

(www.folkhalsomyndigheten.se/publicerat-material/.) Note primary schools were open throughout.

PCR on home self-sampling from a representation sample of nearly 5500 persons 2-89 years. Children 0-15y made up 18.9% of the April and 17.2% of the May sample (i.e. representative).

Prevalence for 0-15y was 0.6% (0.1, 1.7) in April and 0 (0,0) in May, whilst prevalence for 30-59y was 1.0 (0.5, 1.9) in April and 0.6 (0.2, 1.2) in May.

Note that in Stockholm (where a previous report had found no difference in virus prevalence by age), prevalence was 1.5 (0.2, 5.4) in <15y, 8.7 (2.4, 20.8) in 16-29y and 1.0 (0.2, 3.0) in 30-59y in April but 0 in <15y and 16-29y in May, and 1.3 (0.4, 3.4) in 30-59y in May.

2. **England.** Updated data from the ONS COVID-19 Infection Survey as of 27 June. There are no clear differences by age but confidence intervals are wide.

Percentage of individuals ever testing positive between 26 April to 27 June 2020

	% testing positive for COVID-19		95% CI	Sample count ever testing positive	Total number of sample respondents
	Lower	Upper			
2-11	0.29%	0.13%	0.55%	9	3117
12-19	0.31%	0.14%	0.60%	9	2860
20-49	0.42%	0.31%	0.56%	46	10965
50-69	0.28%	0.20%	0.39%	35	12447
<u>70 and above</u>	0.23%	0.13%	0.39%	15	6412
<i>Missing cases</i>	0.38%	0.01%	2.12%	1	260

3. Iceland: Gudbjartsson et al.[13] (<https://pubmed.ncbi.nlm.nih.gov/32289214/>) report the detected prevalence of SARS-CoV-2 in the Icelandic population from 13 March to 6 April 2020. During this time primary schools were open however many but not all secondary schools were closed and there were moderate restrictions on social contacts. PCR was used to identify cases from nasopharyngeal and oropharyngeal samples. An additional targeted testing

group was assessed however those data are not considered here as sampling was not population-based. In the population screening sample, no cases were identified in 848 children under 10 years compared with 100/12,232 (0.8% (0.7, 1.0) amongst those over 10 years. However, participation in the study was primarily by request of participants rather than by random sampling, which may have introduced biases in participation.

Seroprevalence

1. Norwegian national seroprevalence study[17]

(https://www.fhi.no/globalassets/dokumenterfiler/rapporter/2020/covid-19/seroprevalence-of-sars-cov-2-in-the-norwegian-population_report-26-06-2020.pdf). This used an influenza surveillance system to estimate prevalence of IgG from residual serum from 9 regional laboratories in n=900 individuals aged 0-91 years over 4 weeks April-May (weeks 17-20). Note peak incidence in Norway was 26 March (week 13). 10/900 samples were positive, giving national seroprevalence of 1.0% (0.1, 2.4). By age no significant differences:

Table 3. Estimated seroprevalence by age groups in years

Age groups	Positive samples	Number of samples tested (% of all)	Percent positive samples (95% CI)	Seroprevalence [%](95% CrI)
0-4	0	41 (4.6)	0 (0 - 8.6)	1.9 (0.1 - 9.6)
5-14	2	115 (12.8)	1.7 (0.2 - 6.1)	2.33 (0.2 - 6.8)
15-24	2	166 (18.4)	1.2 (0.2 - 4.3)	1.54 (0.2 - 4.7)
25-59	4	372 (41.3)	1.1 (0.3 - 2.7)	1.13 (0.1 - 2.9)
≥60	2	206 (22.9)	1,0 (0.1 - 3.5)	1.16 (0.1 - 3.8)

Note that used residual sera so potential selection bias.

2. Spain – EME Covid study (<https://portalcne.isciii.es/enecovid19/>) and

https://www.mscbs.gob.es/ciudadanos/ene-covid/docs/ESTUDIO_ENE-COVID19_SEGUNDA_RONDA_INFORME_PRELIMINAR.pdf :

a nationally representative sero-prevalence study which collected data from 27 April to 11 May (Round 1).[18] Participants were selected by random sampling of households in municipalities across Spain. Data reported here were from a rapid immunochromatography test (Orient Gene IgG, from Zhejiang Orient Gene Biotech) which did not require venepuncture. Comparison of the rapid test IgG with SARS-CoV-2 serology in 16,953 of the study sample found 97.3% agreement between tests. 60,897 participants provided samples out of 102,803 approached. Those 0-19 years (n=11,464) made up 23% of the sample. Prevalence by age-group was 1.1% in infants, 2.2% for 1-4 year olds, 3.0% for 5-9 year olds, 3.9% for 10-14 year olds and 3.8% for 15-19 year olds compared with 5.5% amongst adults aged 20 or over. Round 2 data was collected 18 May to 1 June on n=63,564 with prevalences 2.2%, 2.4% , 2.9, 3.8 and 3.8% in age-groups <20y compared with prevalences of 4.2-7% amongst adults.

3. England:

A number of seroprevalence studies are being coordinated by PHE. E.g. What's The Story COVID-19. Data from April/May to be available very shortly.

Sub-national seroprevalence studies: there is a rapid increase in regional or city seroprevalence studies. These will be examined in more detail.

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