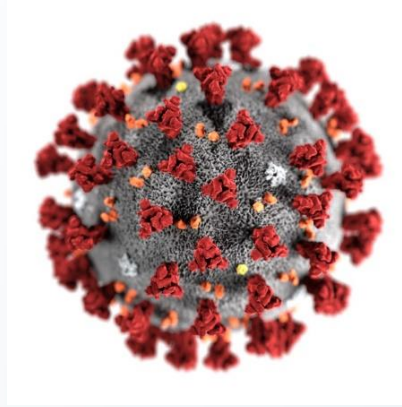


Susceptibility and Ability to Transmit

Lynne Mofenson, MD

Elizabeth Glaser Pediatric AIDS Foundation,
United States





Susceptibility to COVID-19 in Children

Lynne M. Mofenson, M.D.

Senior HIV Technical Advisory

Elizabeth Glaser Pediatric AIDS Foundation



**Elizabeth Glaser
Pediatric AIDS Foundation**

Fighting for an AIDS-free generation



Important to Recognize that Data Continue to be Preliminary and Change Almost Daily - For the Most Part, Definitive Conclusions Cannot Yet be Drawn

HOW TO INTERPRET THE DELUGE OF DATA?





Can Children Get Infected by SARS-CoV-2?

POLITICS

Trump says schools should reopen because children are 'virtually immune'

David Jackson USA TODAY

Published 10:02 a.m. ET Aug. 5, 2020 | Updated 2:39 p.m. ET Aug. 5, 2020



YES!
Children can get infected

[POLITICS](#)

Trump says schools should reopen because children are 'virtually immune'

[David Jackson](#) USA TODAY

Published 10:02 a.m. ET Aug. 5, 2020 | Updated 2:39 p.m. ET Aug. 5, 2020

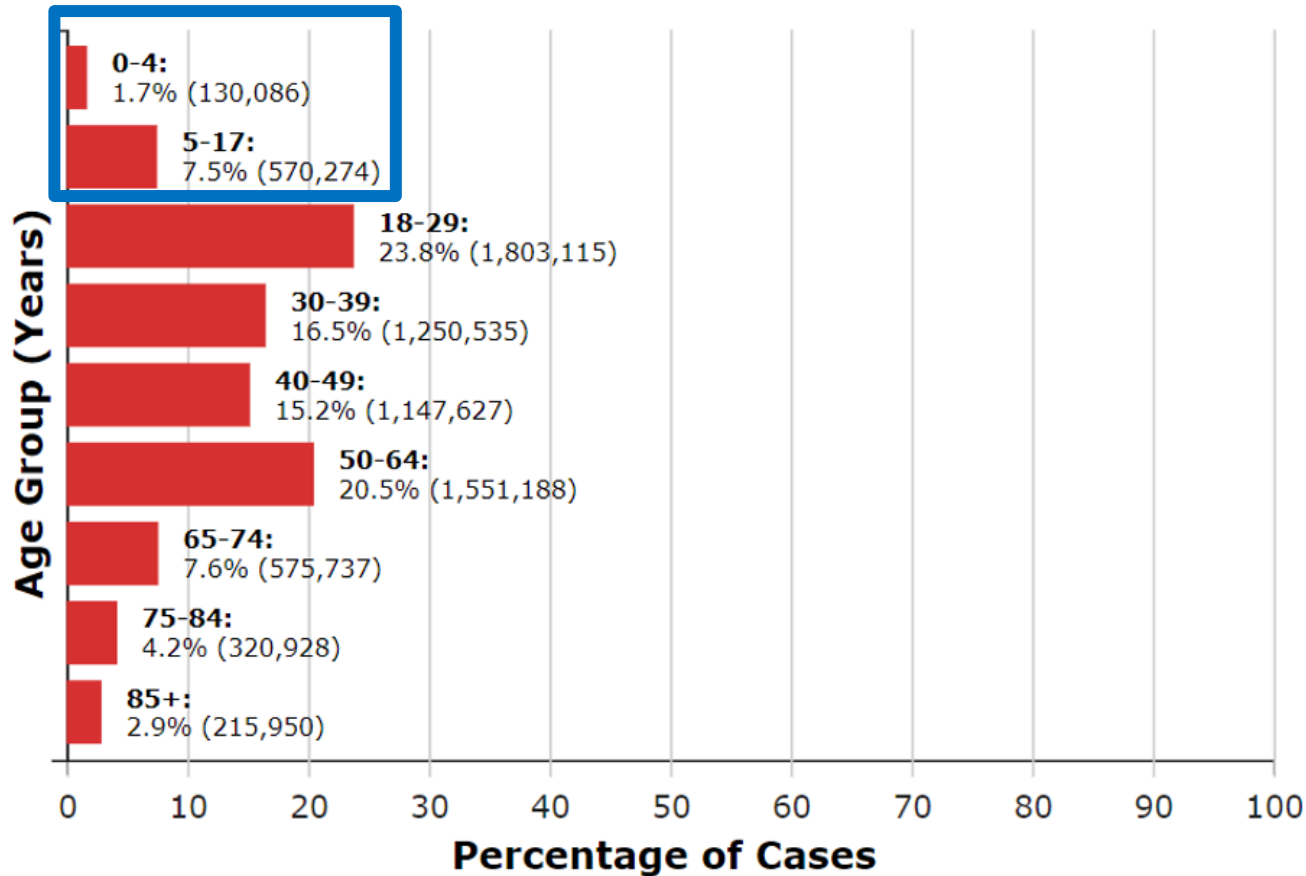
CDC COVID Data Tracker

Maps, charts, and data provided by the CDC

CDC | Updated: Nov 11 2020 12:17PM

Cases by Age Group:

Data from 7,581,456 cases. Age group was available for 7,565,440 (99%) cases.



<https://covid.cdc.gov/covid-data-tracker/#demographics>

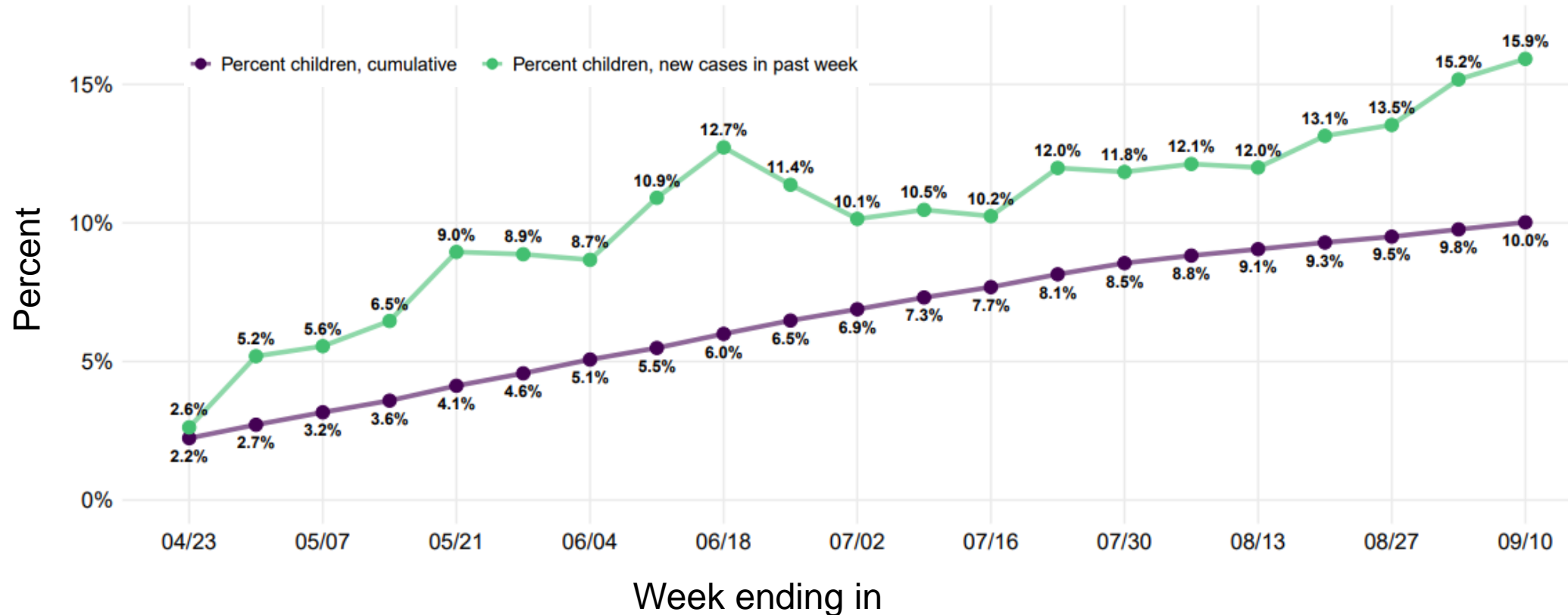
COVID-19 in Children, United States

- While the number of cases in **children** is less than in adults, 700,360 children 0-17 years have had laboratory-confirmed infection (9.2% of all infections).
- Children are less likely to be tested than adults as less likely symptomatic, so true prevalence in children is really not known.

Trends in Pediatric COVID-19, United States April – September 2020

Sisk B et al. *Pediatrics*. 2020 Sept 29;e2020027425 (epub)

Percent of COVID-19 Cases that were Children: Cumulative and New Cases in Past Week



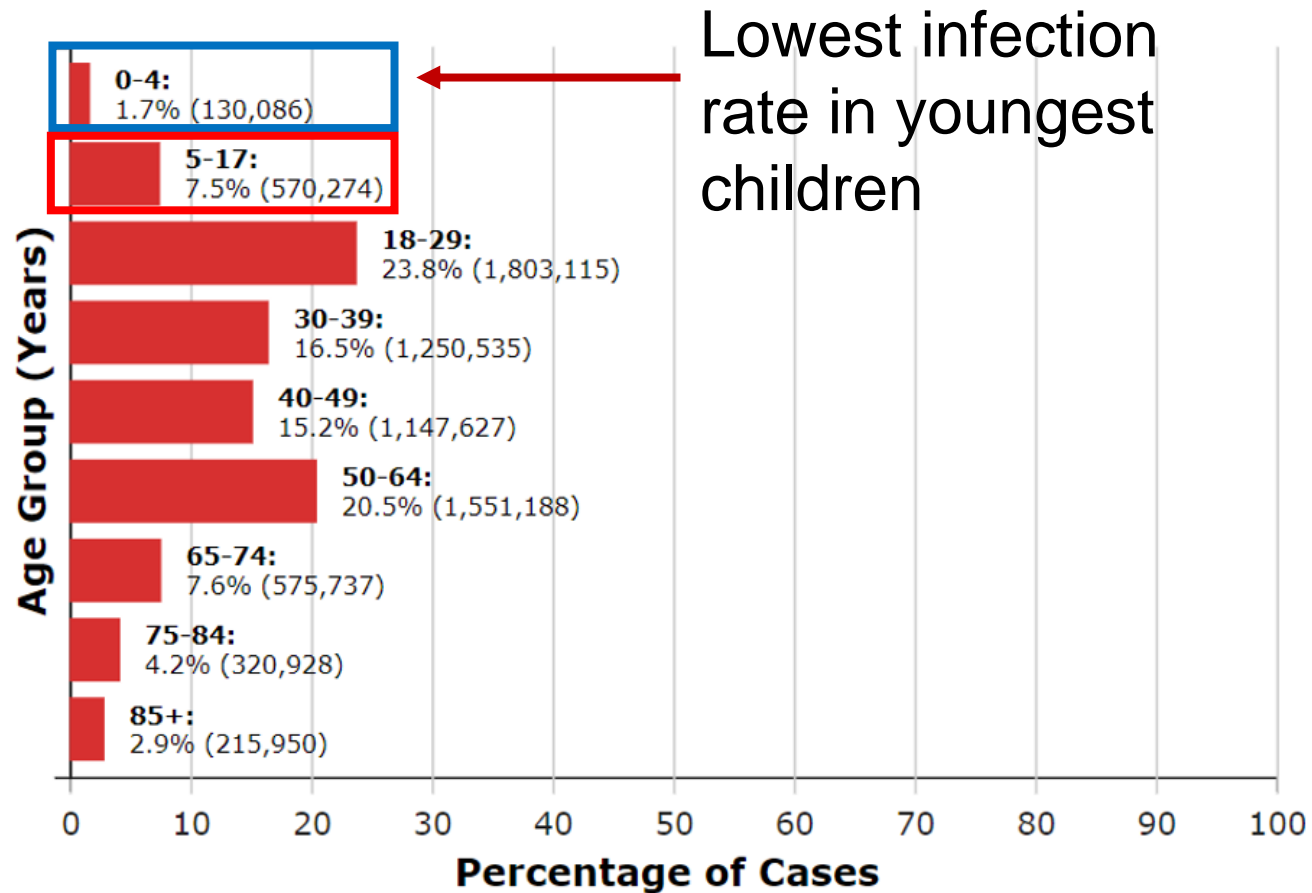
CDC COVID Data Tracker

Maps, charts, and data provided by the CDC

CDC | Updated: Nov 11 2020 12:17PM

Cases by Age Group:

Data from 7,581,456 cases. Age group was available for 7,565,440 (99%) cases.



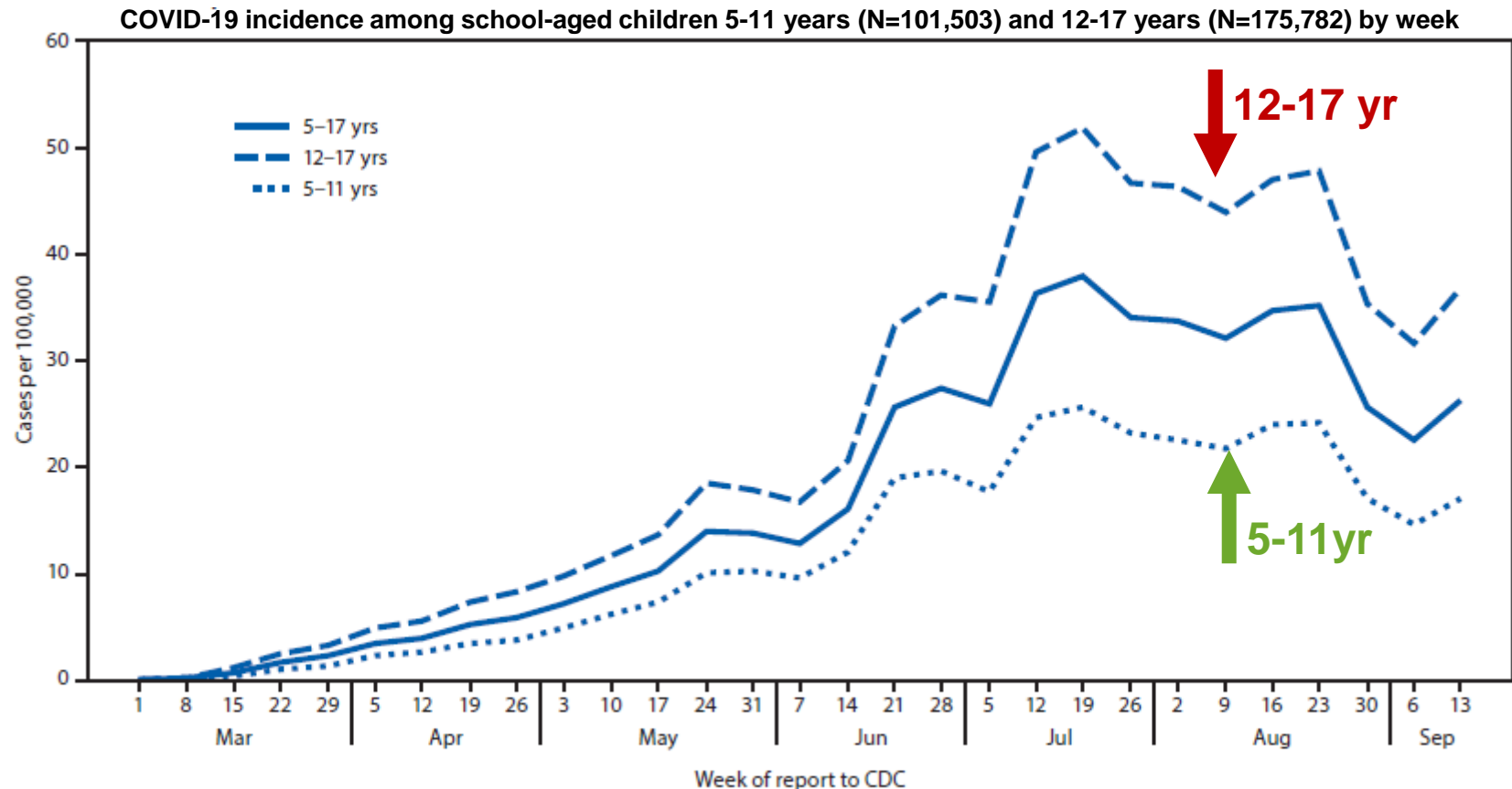
- There may be a difference in infection rate between young children and older children
- Note that school-aged children age 5-17 years are grouped together in this report.

COVID-19 Trends Among School-Aged Children — United States, March 1–September 19, 2020

Rebecca T. Leeb, PhD¹; Sandy Price¹; Sarah Sliwa, PhD¹; Anne Kimball, MD^{1,2}; Leigh Szucs, PhD¹; Elise Caruso, MPH¹; Shana Godfred-Cato, DO¹; Matthew Lozier, PhD¹

Increasing Trend in COVID-19 Cases in School-Aged Children Over Time

- 277,285 lab-confirmed COVID-19 cases in school-aged children aged 5-17 years in US from Mar-Sept 2020



→ As mitigation restrictions eased in summer, increase in infections in children seen

→ As observed earlier, incidence among **adolescents** almost double that in **younger children**.

Sources: CDC COVID-19 case report form. <https://wwwn.cdc.gov/nndss/covid-19-response.html>. CDC National Notifiable Disease Surveillance System. <https://www.cdc.gov/nndss>.

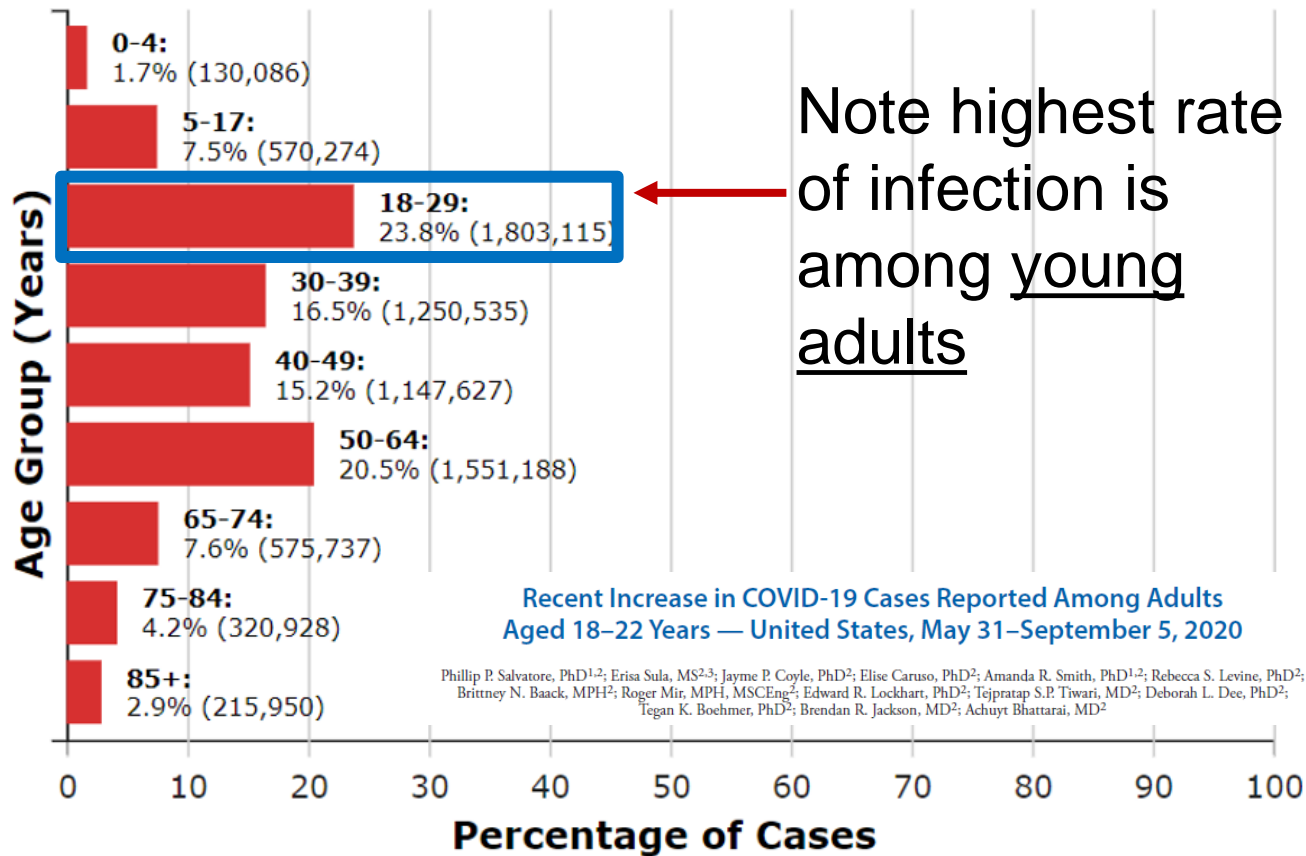
CDC COVID Data Tracker

Maps, charts, and data provided by the CDC

CDC | Updated: Nov 11 2020 12:17PM

Cases by Age Group:

Data from 7,581,456 cases. Age group was available for 7,565,440 (99%) cases.



<https://covid.cdc.gov/covid-data-tracker/#demographics>

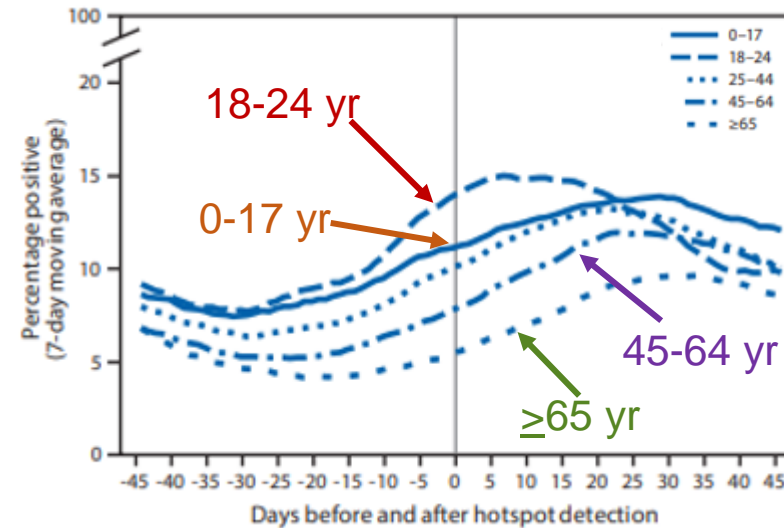
Role of Young Adults

Morbidity and Mortality Weekly Report

October 9, 2020

Transmission Dynamics by Age Group in COVID-19 Hotspot Counties — United States, April–September 2020

Alexandra M. Oster, MD¹; Elise Caruso, MPH¹; Jourdan DeVies, MS¹; Kathleen P. Hartnett, PhD¹; Tegan K. Boehmer, PhD¹



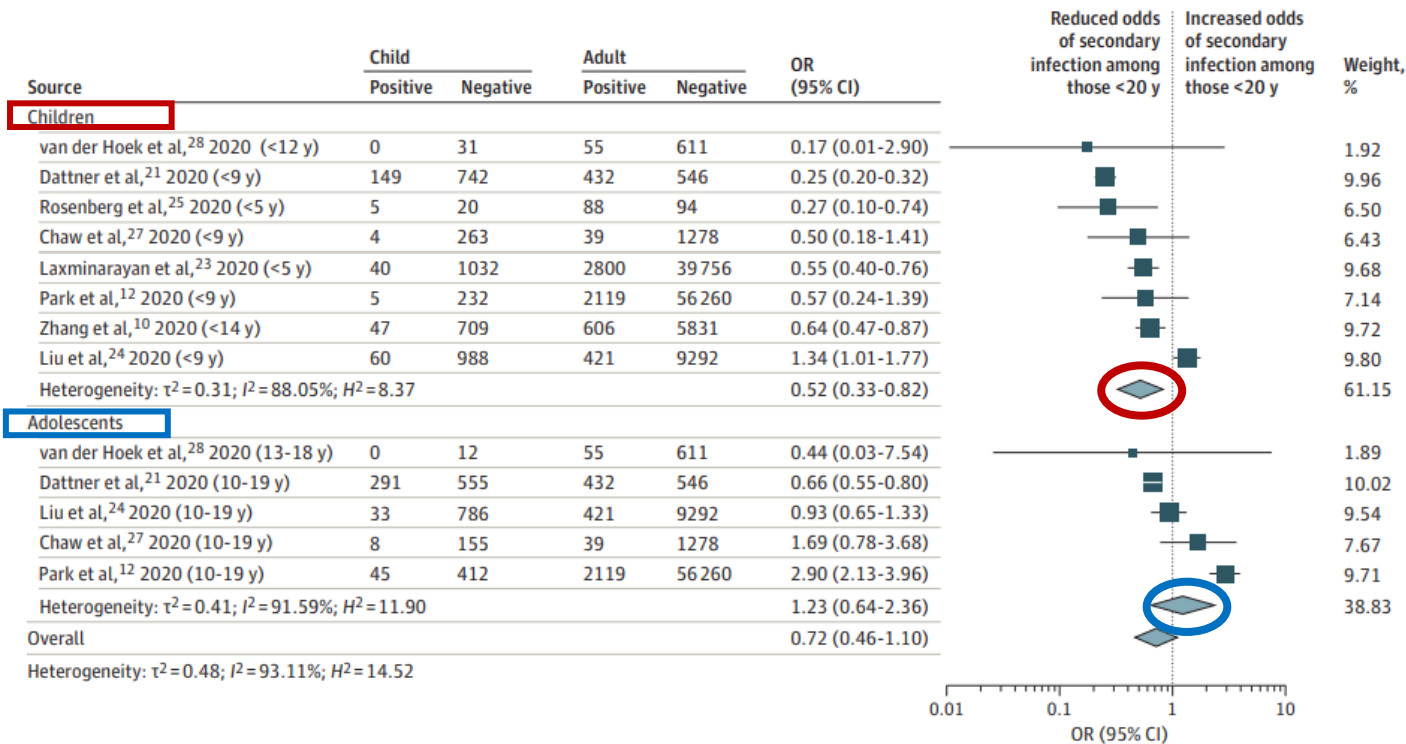
- Prior to counties being labeled as hot spots, highest % + was in **ages 18-24 years** (14%), followed by **ages 0-17** (11%).
- The increase in children/youth was followed *after several weeks* by increasing % + in older adults age **45-64** and **≥65 yr**

Susceptibility to SARS-CoV-2 Infection Among Children and Adolescents Compared With Adults
A Systematic Review and Meta-analysis

Russell M. Viner, PhD; Oliver T. Mytton, PhD; Chris Bonell, PhD; G. J. Melendez-Torres, PhD; Joseph Ward, MBBS; Lee Hudson, PhD; Claire Waddington, DPhil; James Thomas, PhD; Simon Russell, PhD; Fiona van der Klis, PhD; Archana Koirala, MBChB; Shamez Ladhani, MD; Jasmina Panovska-Griffiths, PhD; Nicholas G. Davies, DPhil; Robert Booy, MD; Rosalind M. Eggo, PhD

Possible Difference in Susceptibility to SARS-CoV-2 Younger vs Older Children?

Figure 3. Pooled Estimate of Odds of Being an Infected Contact Among Children and Among Adolescents Compared With Adults for Contact-Tracing Studies

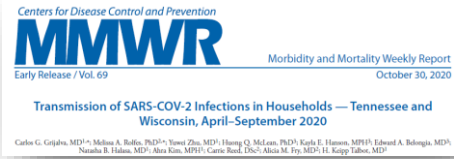


→ Reduced likelihood of secondary infection in **children <10 years** than adults.

→ Likelihood of secondary infection in **youth 10-19 years** - data very heterogeneous and not significantly different than adults.

Children included those younger than 10 years, adolescents included those aged 10 to 19 years, and adults included those 20 years and older. OR indicates odds ratio.

While Many Studies Suggest Children, Particularly Younger Children, Have Lower Susceptibility, Others Find Similar Secondary Infection Rates



Grijalva CG et al. *MMWR* 2020 Nov 6;69:1631-4

- Household transmission study in TN and WI: Enrolled 101 households with index case diagnosed <7 d prior to enrollment and 191 household members with evaluation at 7 days FU.

Characteristic	Laboratory-confirmed SARS-CoV-2 infections/ Household members at risk	Secondary infection rate % (95% CI)*
All household members	102/191	53 (46–60)
Household member age group, yrs		
<12	18/32	57 (39–72)
12–17	14/30	47 (30–64)
18–49	54/92	59 (48–68)
≥50	16/37	43 (29–59)

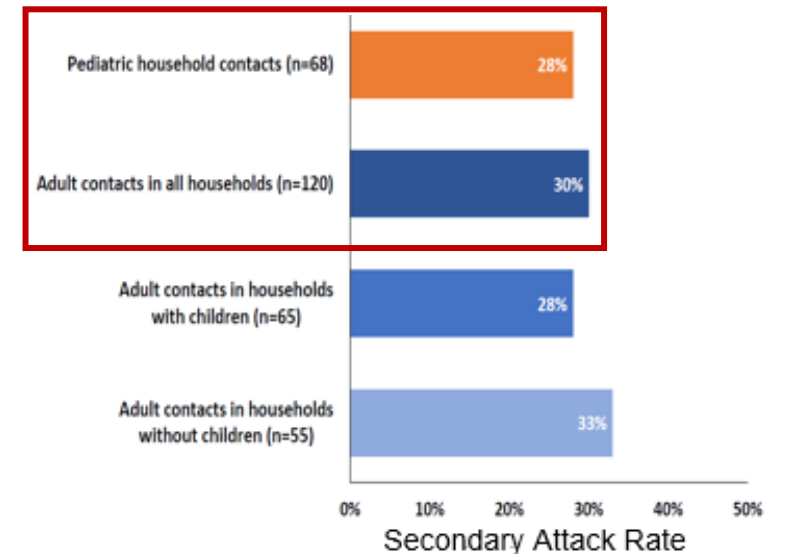
PEDIATRICS

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

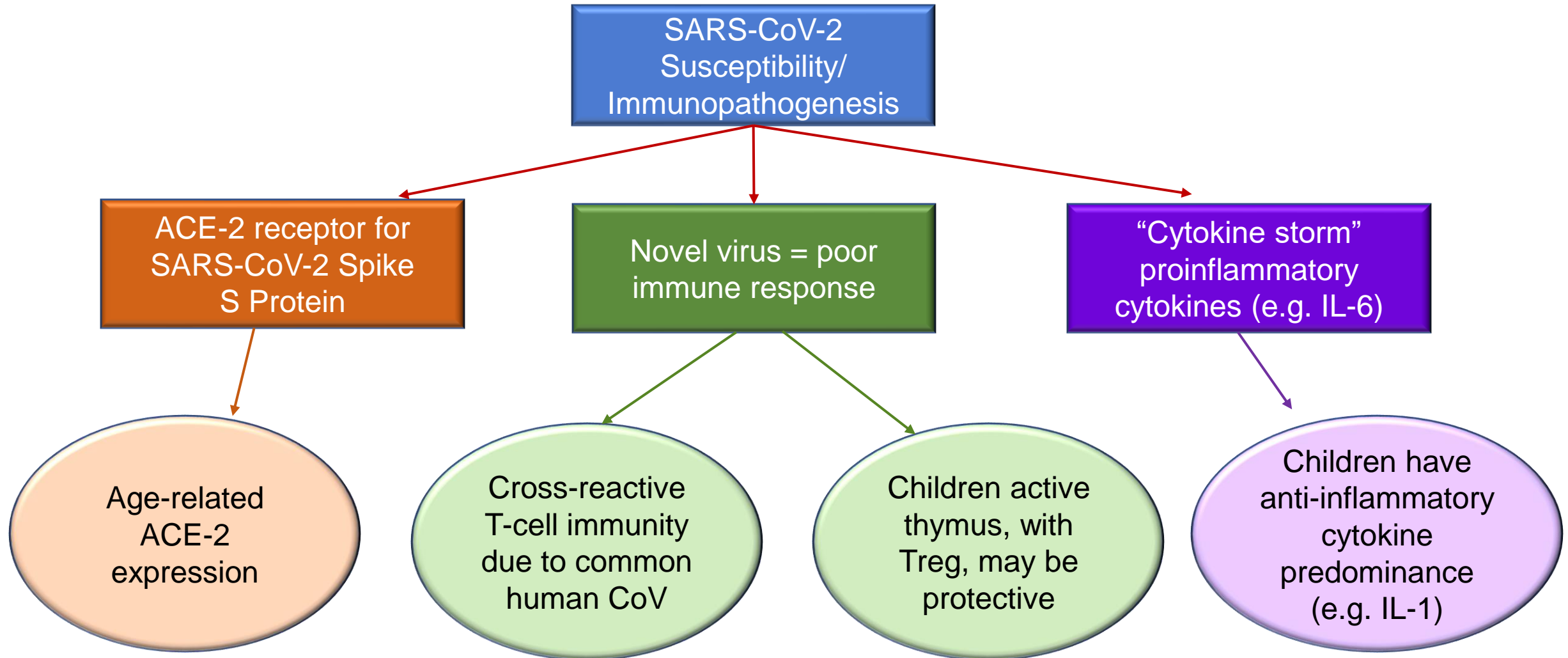
Symptoms and Transmission of SARS-CoV-2 Among Children—Utah and Wisconsin, March–May 2020

Laws RL et al. *Pediatrics*. 2020 Oct 8;e2020027268

- Household transmission study in WI and UT: Enrolled 58 households with an index case diagnosed <10 d prior to enrollment and 88 household contacts, with 14 d FU.

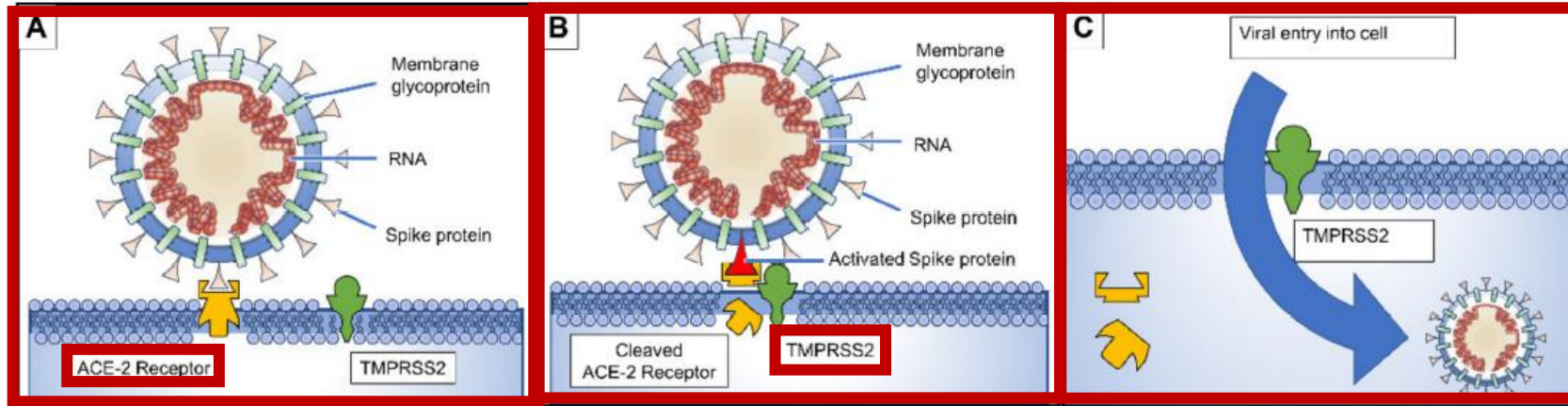


Hypotheses for Potential Lower Susceptibility and/or Milder Disease Severity in Children Compared to Adults

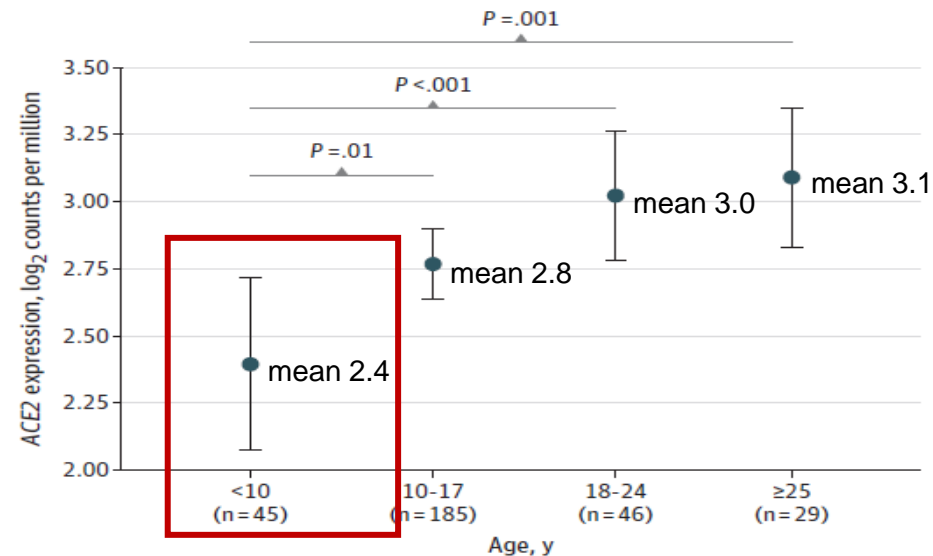


Potential protective factors in children

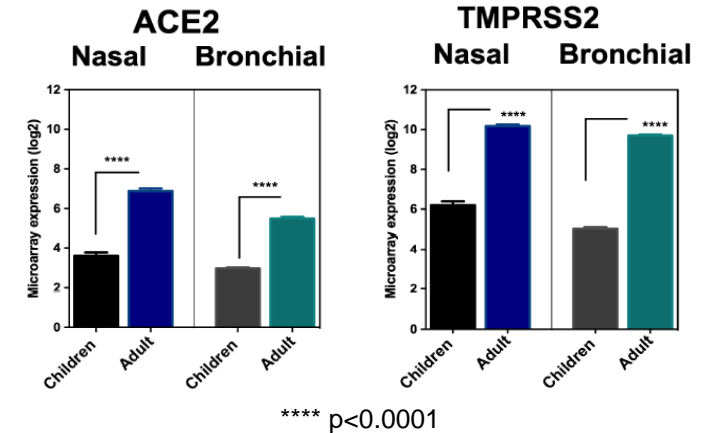
Younger Children May Have Fewer Receptors for SARS-CoV-2 in Their Respiratory Tract



→ Two studies have found lower levels of ACE-2 and TMPRSS2 expression in the respiratory tract of children, particularly those <10 years.



Bunyavanich S et al. JAMA. 2020;323:2427-9



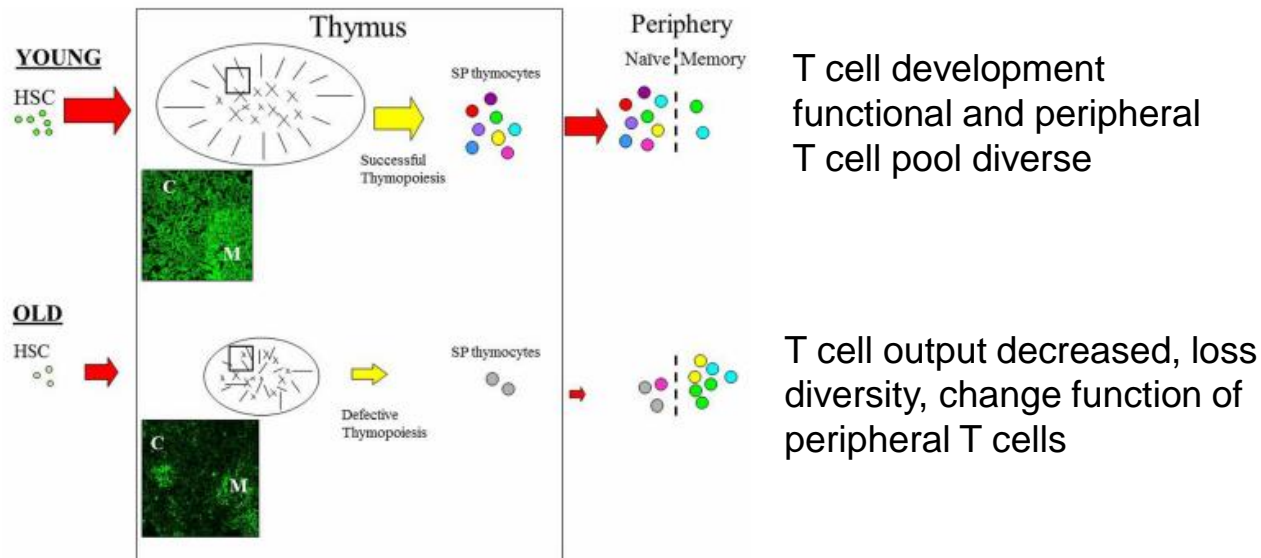
Sharif-Askari NS et al. Molec Ther Methods Clin Develop. 2020 Sept; Vol 18

Other Possible Hypotheses for Lower Susceptibility/ Milder Disease Severity

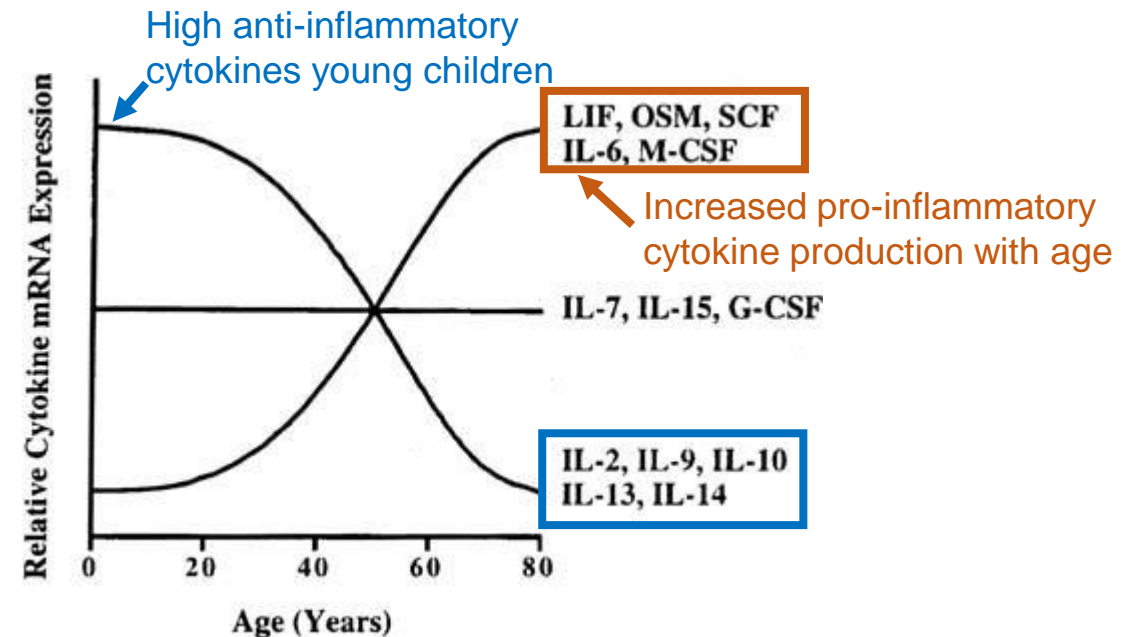
- Hypothesize that human coronaviruses (hCoV) associated with common colds in children may offer some protection due to cross-reactive T-cell immunity between hCoV and SARS-CoV-2.
 - *Mateus J et al. Science. 2020 Oct 2;370:89-94:*
 - In blood samples derived prior to 2019, found CD4⁺T cells that react to SARS-CoV-2 epitopes that cross-react with corresponding homologous sequences from many of the commonly circulating human CoVs, and that these reactive cells are largely memory CD4⁺ T cells.
 - In contrast, neutralizing antibodies are human CoV species-specific and do *not* show cross-reactivity with SARS-CoV-2.

Other Possible Hypotheses for Lower Susceptibility/ Milder Disease Severity

- Active thymus activity and T lymphocyte function (high levels regulatory T cells) in children may protect against infection and severity. (*Gunes H et al. Euro J Pediatr. 2020 Oct 13;1-4.*) Thymus decreases in both function and activity after infancy, active adolescents, involution adults.
- Children high levels of anti-inflammatory (e.g., IL2) and low levels pro-inflammatory cytokines (e.g. IL-6) – “inflamm-aging” as age.



Palmer DB. *Front Immunol.* 2013;4:1-6





Trump, DeVos downplay risks of reopening schools, claim children don't spur transmission: FACT CHECK

DeVos has falsely claimed the children are "stoppers" of COVID-19.

By Libby Cathey

July 24, 2020, 5:40 PM • 13 min read

Can Children With SARS-CoV-2 Infection Transmit to Others?

HEALTH AND SCIENCE

CDC director says there's no data children drive coronavirus spread — but the U.S. isn't testing many kids

DeVos's claim that children are 'stoppers' of covid-19

Fact Checker • Analysis



Trump, DeVos downplay risks of reopening schools, claim children don't spur transmission: FACT CHECK

DeVos has falsely claimed the children are "stoppers" of COVID-19.

By Libby Cathey

July 24, 2020, 5:40 PM • 13 min read

Mixed Data
Children can transmit but extent is unclear

HEALTH AND SCIENCE

CDC director says there's no data children drive coronavirus spread — but the U.S. isn't testing many kids



What About Transmission of SARS-CoV-2 from Children to Others?

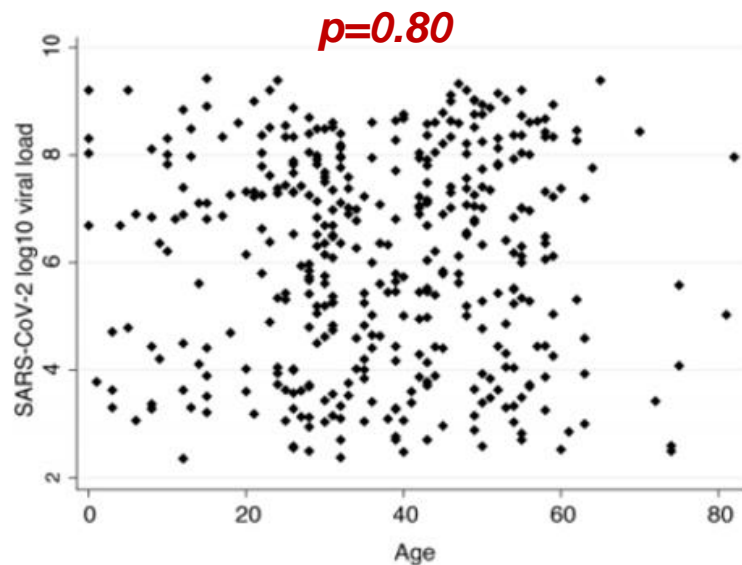
- The role that children and young people play in transmission of SARS-CoV-2 depends on multiple factors:
 - **Risk of exposure to infected individual:** children less likely to be exposed during mitigation interventions
 - **Probability of being infected upon exposure:** young children *may* have lower susceptibility
 - **Extent develops symptoms:** children more likely asymptomatic
 - **Propensity to make potentially infectious contact with others** (number of social contacts across age groups): school re-openings increase possibility
 - **Extent develops viral load sufficiently high to transmit and duration of infectiousness:** mixed data on viral load in children vs adults

Similar SARS-CoV-2 Viral Load in the Upper Respiratory Tract of Children and Adults with Symptomatic Early Acute COVID-19

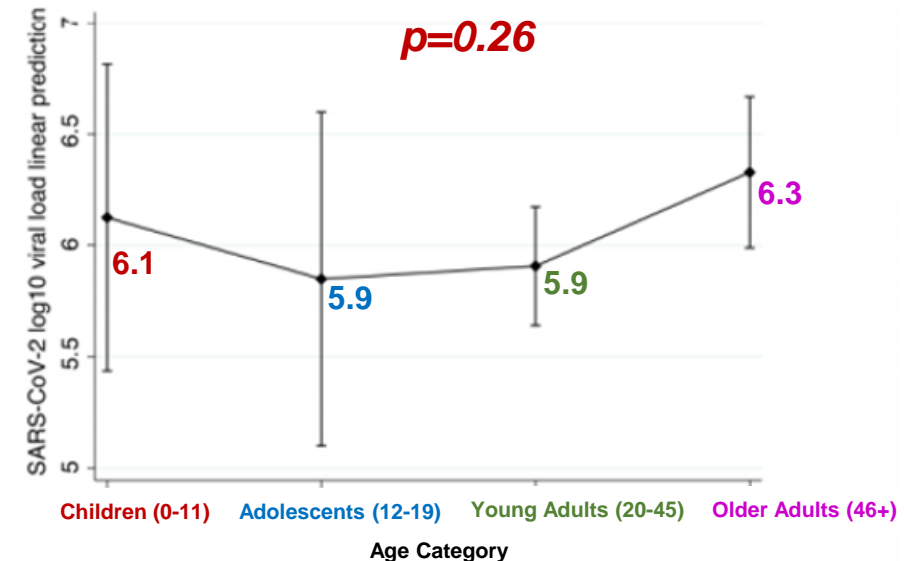
Baggio S et al. Clin Infect Dis. 2020 Aug 6;ciaa1157

- Evaluated viral load (calculated by cycle threshold of PCR) at time of diagnosis in 53 children and 352 adults with *symptomatic* COVID-19 tested within 5 days of diagnosis in Geneva.
- No significant differences in viral load between adults and children with symptomatic COVID-19.

Scatterplot of Age (Continuous) vs Log10 SARS-CoV-2 VL



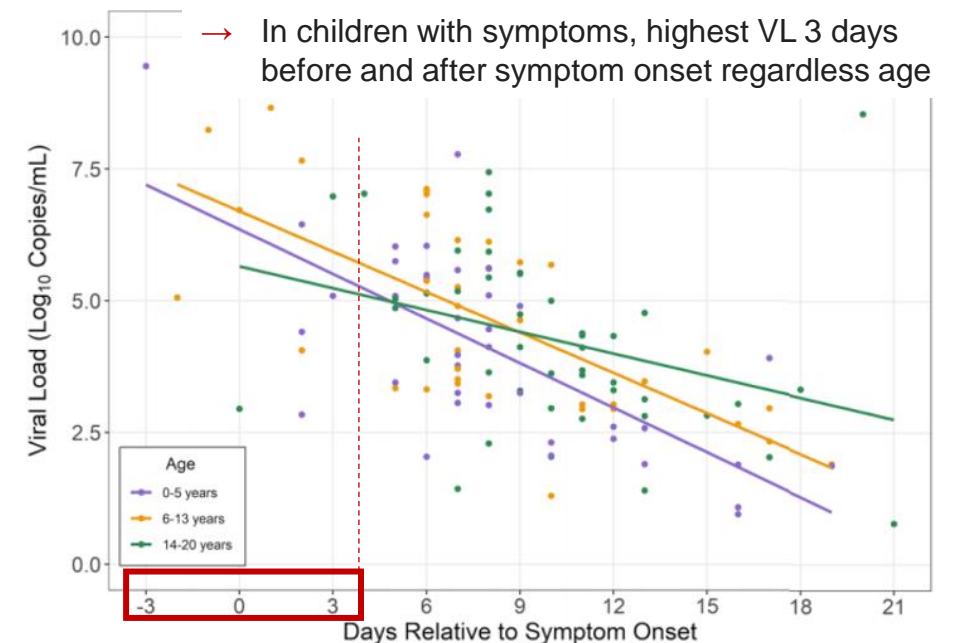
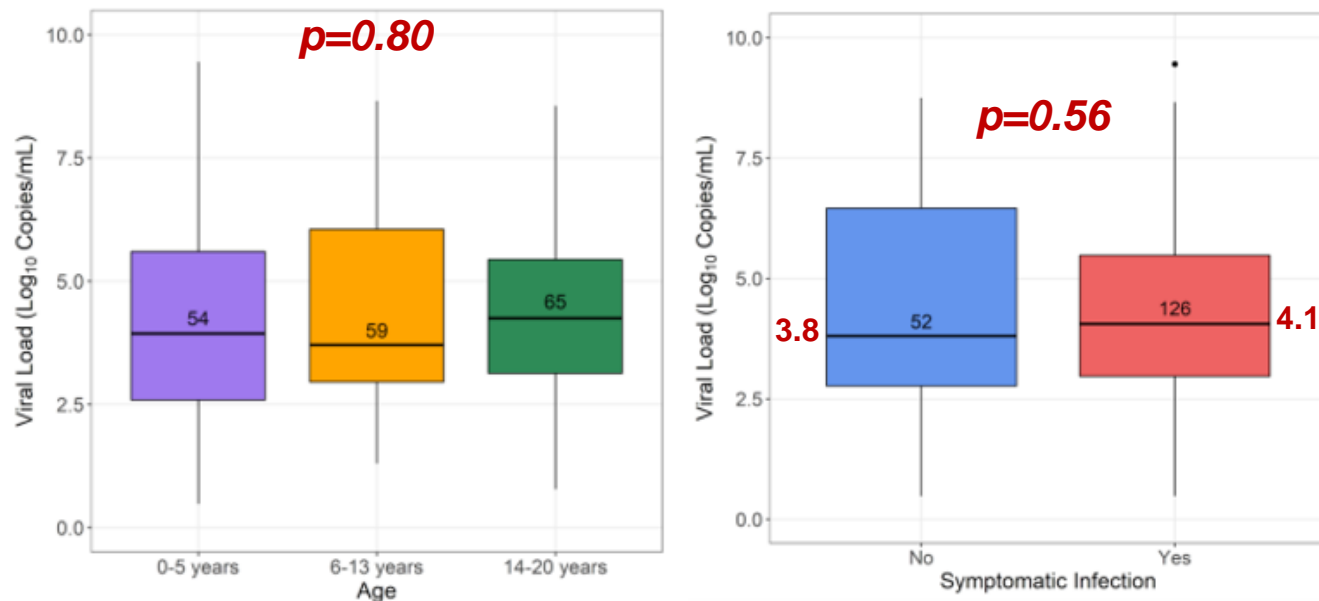
Mean/95% CI of Log10 SARS-CoV-2 VL by Age Group



Similar SARS-CoV-2 Viral Load in Children Regardless of Age Category and Symptom Status

Hurst JH et al. Clin Infect Dis. 2020 Nov 3;ciaa1693

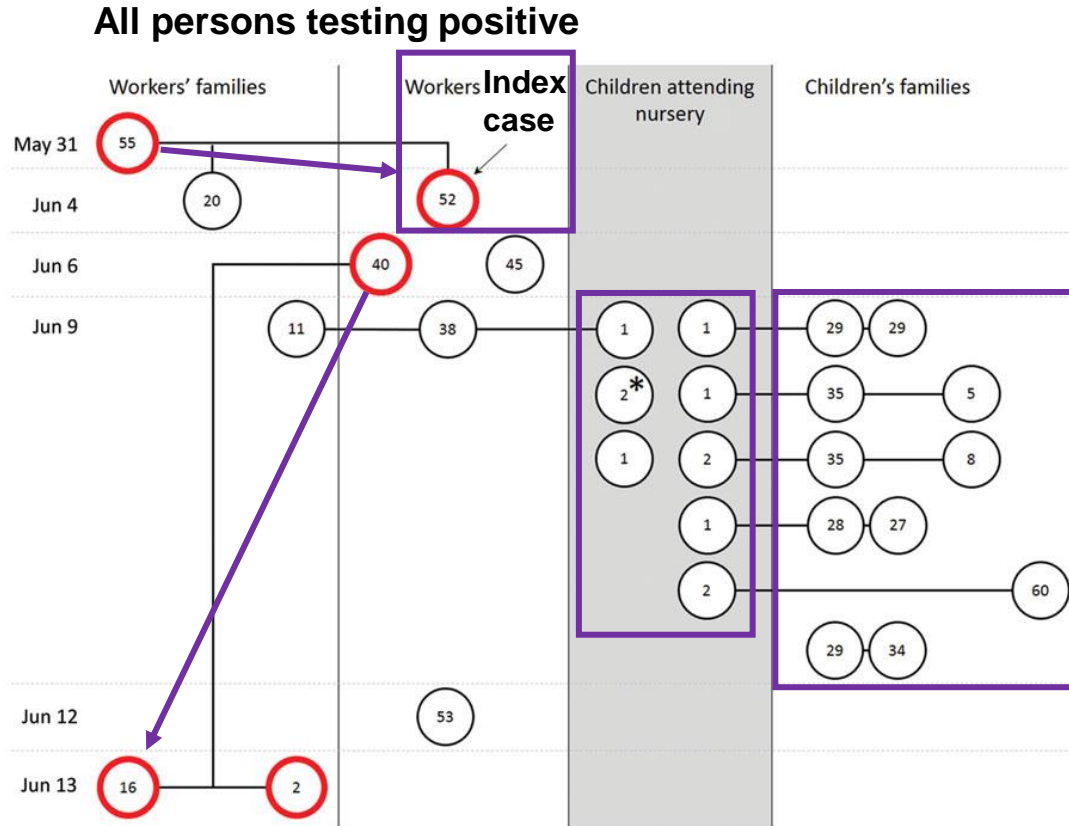
- Prospective cohort of 382 children/youth (<21 years) from 204 households with infected index case; on PCR screening, 293 (77%) infected, 30% asymptomatic and 70% symptomatic.
- Quantitative PCR in 178 samples; viral load did not differ by age group or symptomatic vs asymptomatic children, no correlation with any reported symptom.



Transmission CAN Occur: SARS-CoV-2 Outbreak in Nursery, Poland

Okarska-Napierata M et al. *Emerg Infect Dis.* 2020 Oct

- Following notification that a staff member was exposed, PCR-based testing conducted among infants, staff, and family members of infants and staff.



- Outbreak resulted in 29 confirmed infections, representing 27% of persons tested, including
 - 8 children at nursery (no symptoms)
 - 12 family members with no direct exposure to nursery
- Illustrates transmission can occur among infants/children and staff in childcare settings and at home and that transmission associated with such outbreaks can extend into the community.

- Dates indicate first + results in consecutive case-patients.
- Circles indicate infected case-patients and age (yr); red=symptoms
- Line indicate household members
- * Child whose parent tested negative but positive in prior 2 weeks

- Following n
- among child

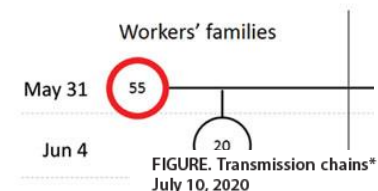
ed testing conducted

All persons tes

Transmission Dynamics of COVID-19 Outbreaks Associated with Child Care Facilities — Salt Lake City, Utah, April–July 2020

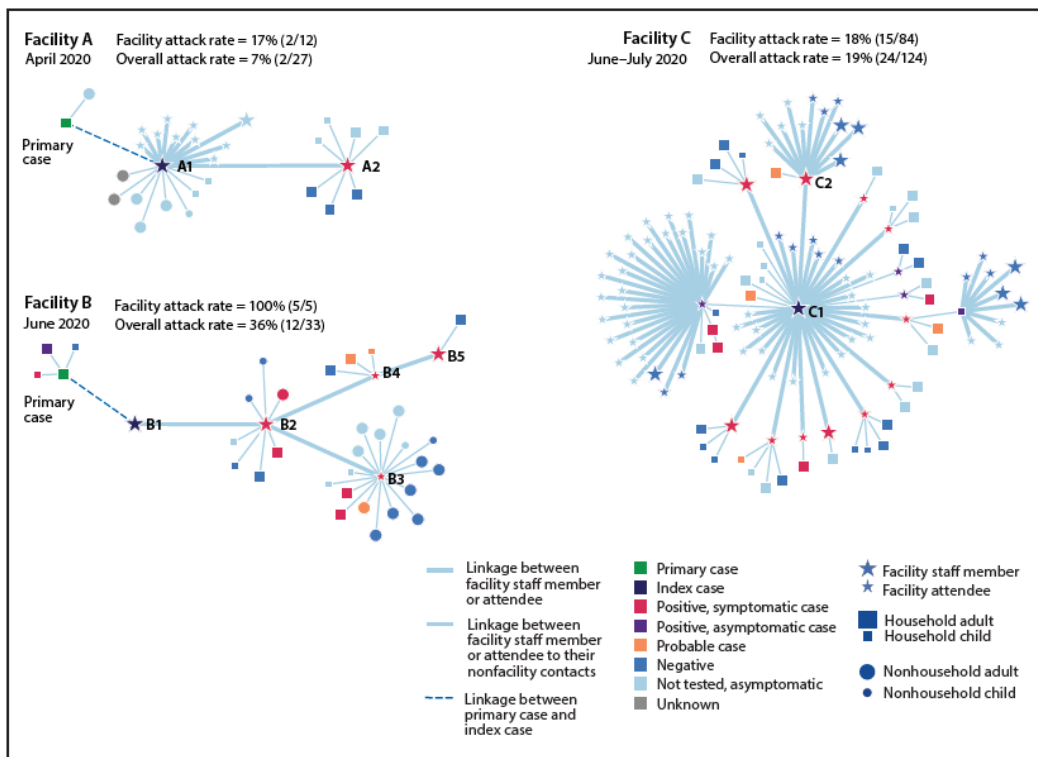
Adriana S. Lopez, MHS¹; Mary Hill, MPH²; Jessica Antezano, MPA²; Dede Vilven, MPH²; Tyler Rutner²; Linda Bogdanow²; Carlene Claflin²; Ian T. Kralalik, PhD¹; Victoria L. Fields, DVM¹; Angela Dunn, MD³; Jacqueline E. Tate, PhD¹; Hannah L. Kirking, MD¹; Tais Kirshikova²; Ilona Diekema²; MDA²; Cuc H. Tran, PhD¹

FIGURE. Transmission chains* and attack rates†,§ in three COVID-19 child care center outbreaks^{¶,**,††} — Salt Lake County, Utah, April 1–



irmed infections,
s tested, including

no symptoms)



What is added by this report?

Twelve children acquired COVID-19 in child care facilities. Transmission was documented from these children to at least 12 (26%) of 46 nonfacility contacts (confirmed or probable cases). One parent was hospitalized. Transmission was observed from two of three children with confirmed, asymptomatic COVID-19.

What are the implications for public health practice?

SARS-CoV-2 Infections among young children acquired in child care settings were transmitted to their household members. Testing of contacts of laboratory-confirmed COVID-19 cases in child care settings, including children who might not have symptoms, could improve control of transmission from child care attendees to family members.

- Dates in
- Circles i
- Line ind
- * Child v

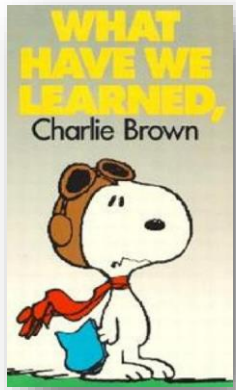
re

multiple

ren

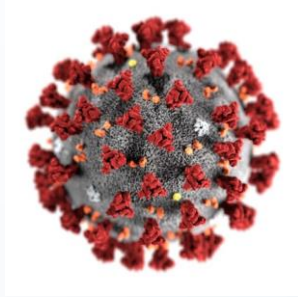
and

d



Summary

- Children are not “immune to SARS-CoV-2”; they are susceptible and can be infected.
- However, some (but not all) data suggests that younger children (age <10 years) may be less susceptible to infection than older children.
 - This lower susceptibility, if real, may be mediated by lower levels of the SARS-CoV-2 receptor ACE2 in the upper and lower respiratory tract of young children.
 - Data are confounded by the lack of testing among children due to more asymptomatic infection and the effect of mitigation on likelihood of exposure of children to infected individuals; as mitigation measures decrease, there has been an increase in pediatric infections.
 - Further research is needed to better assess susceptibility and transmissibility among children.



Thank you for your attention!

