COVID-19 Science Update

The *COVID-19 Science Update* summarizes new and emerging scientific data for public health professionals to meet the challenges of this fast-moving pandemic. Weekly, staff from the CDC COVID-19 Response and the CDC Library systematically review literature in the WHO COVID-19 database, and select publications and preprints for public health priority topics in the CDC Science Agenda for COVID-19 and CDC COVID-19 Response Health Equity Strategy.

Vaccines

PREPRINTS (NOT PEER-REVIEWED)

Durability of antibody responses elicited by a single dose of Ad26.COV2.S and substantial increase following late boosting. Sadoff *et al*. medRxiv (August 26, 2021).

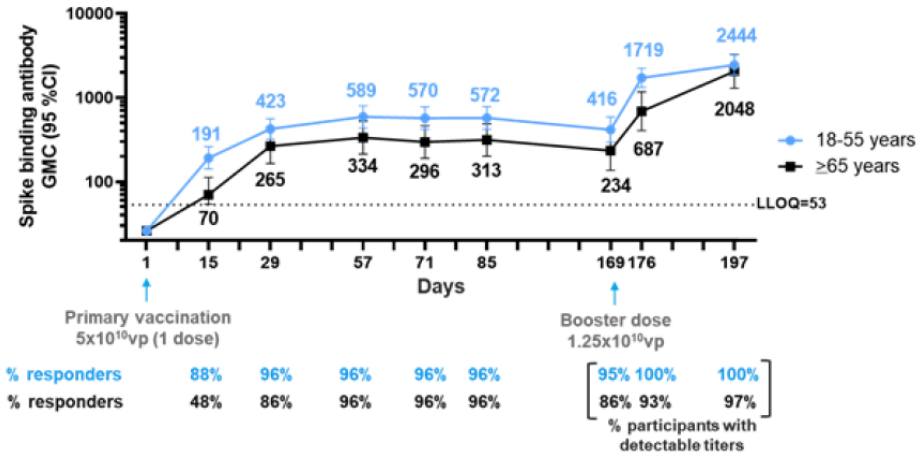
Key findings:

- 6–9 months after a single dose of Ad26.COV2.S vaccine (Johnson & Johnson/Janssen), neutralizing and binding antibody levels remained at or above post-vaccination levels in most recipients (Figure).
  - Among persons aged 18–55 years, antibody levels were similar at 1 month and 6 months.
  - Among persons aged ≥65 years, antibody levels were lower but also stable in this time frame.
- A booster dose given 6 months after primary vaccination increased binding antibody levels by 9-fold.

Methods: Neutralizing and binding antibodies were assessed in Phase 1/2a clinical trial participants (Cohort 1a, aged 18–55 years, N = 25; Cohort 2a, aged 18–55 years boosted at 6 months, N = 17; Cohort 3, aged ≥65 years, N = 22) and Phase 2 (aged 18–55 years and aged ≥65 years boosted at 6 months, N = 73). *Limitations*: Small manufacturer's study not designed to assess vaccine effectiveness or adverse events.

Implications: Antibody levels following a single dose of Ad26.COV2.S vaccine appeared durable for at least 6 months, and a booster dose of Ad26.COV2.S vaccine given at 6 months might enhance immune memory.

Figure:



Note: Adapted from Sadoff *et al.* Antibody levels in phase 2 clinical trial participants **aged 18–55 years** and **aged ≥65 years** who received primary vaccination with Ad26.COV2.S at day 1, and a booster dose at day 169 (6 months).
Geometric mean concentrations (GMCs) shown above each time point. Licensed under CC-BY-NC-ND 4.0.

Waning immunity of the BNT162b2 vaccine: A nationwide study from Israel. Goldberg *et al.* medRxiv (August 30, 2021). **Published in NEJM as Waning immunity after the BNT162b2 vaccine in Israel (December 9, 2021).**

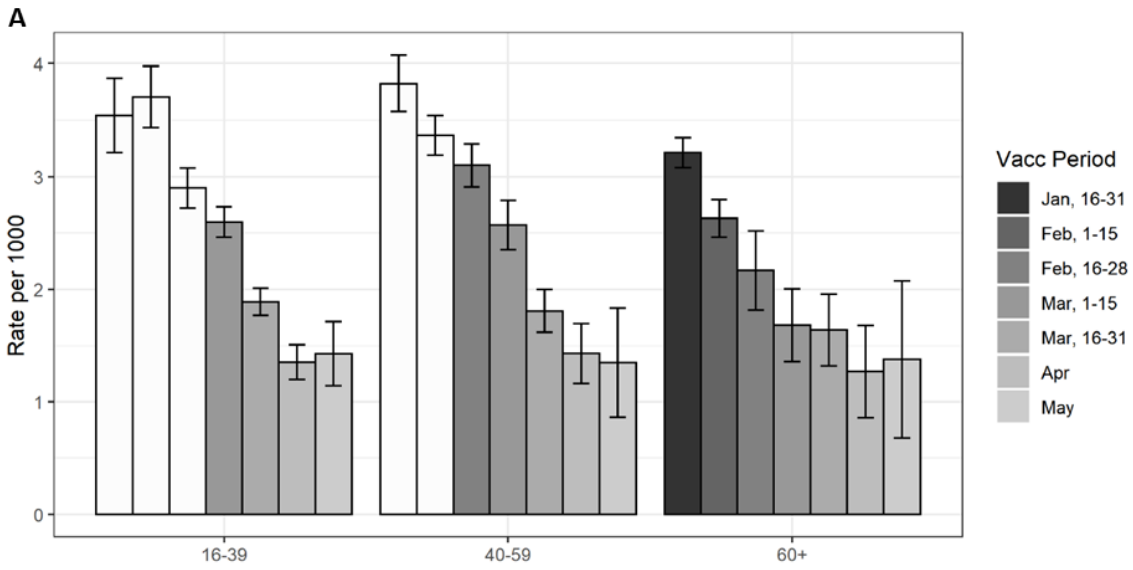
Key findings:

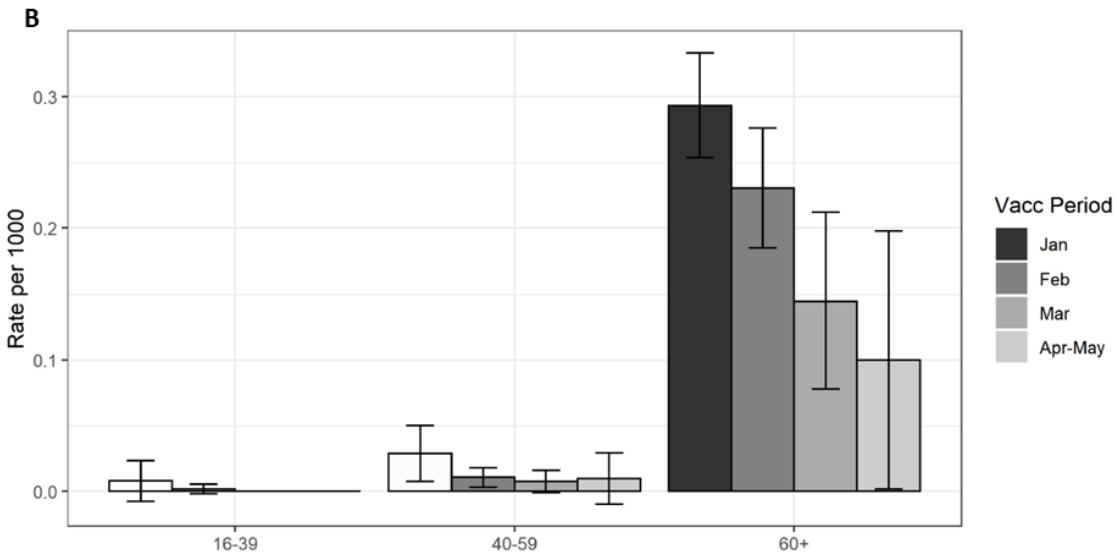
- After vaccination with 2 doses of BNT162b2 vaccine (Comirnaty, Pfizer/BioNTech), rates of SARS-CoV-2 infection and severe COVID-19 in persons aged ≥16 years in Israel appear to have increased with time since vaccination along with emergence of the Delta variant in June 2021. Similar patterns were observed in all age groups.
    - Rate of SARS-CoV-2 infection among persons aged ≥60 years was 3.2 per 1,000 persons fully vaccinated in January, and 1.6 per 1,000 persons fully vaccinated in late March. (Figure 1)
    - Rate of severe COVID-19 among persons aged ≥60 years was 0.29 per 1,000 persons fully vaccinated in January, and 0.10 per 1,000 persons fully vaccinated in April–May. (Figure 2)

Methods: Rates calculated using positive PCR test results for SARS-CoV-2 during July 11–31, 2021, among 4.8 million Israel residents (aged ≥16 years) fully vaccinated with BNT162b2 vaccine prior to June 1, 2021. *Limitations*: Study cannot distinguish possible contributions of waning immunity versus higher community transmission of the Delta variant.

Implications: Breakthrough infections and severe disease from the Delta variant appear to have increased with time since vaccination, which might prompt consideration of booster doses for people who have been vaccinated previously. However, more definitive evidence is needed regarding duration of immunity following vaccination.

Figures:





Note: Adapted from Goldberg *et al.* **A)** Rate of SARS-CoV-2 infections, by age group (years) and vaccination period in 2021. **B)** Rate of severe COVID-19, by age group (in years) and vaccination period in 2021. White bars represent time periods during which groups were not yet eligible for vaccination in Israel. Permission request in process.

Prevention Strategies and Non-Pharmaceutical Interventions

PREPRINTS (NOT PEER-REVIEWED)

The impact of community masking on COVID-19: a cluster-randomized trial in Bangladesh. Abaluck *et al*. EliScholar (August 31, 2021).

Key findings:

- A randomized trial of surgical or cloth mask distribution, role-modeling, and active mask promotion tripled mask use to 42.3% in intervention villages (N = 797,715 observations) from 13.3% in comparison villages (N = 806,547 observations).
- In villages receiving mask interventions, symptomatic seroprevalence of SARS-CoV-2 was reduced by 9.3% relative to comparison villages.
- In villages randomized to receive surgical masks, symptomatic seroprevalence of SARS-CoV-2 was significantly lower (relative reduction 11.2% overall).
- Changes were sustained for at least 2 weeks. No adverse events were reported during the study period.

Methods: In a large cluster-randomized trial in rural Bangladesh (N = 600 villages, N = 342,126 adults), intervention villages received free surgical or cloth masks, information on the importance of mask use, role modeling by community leaders, and in-person reminders for 8 weeks during November 2020–April 2021. Comparison villages did not receive any interventions. Participants were surveyed for COVID-related symptoms (weeks 5 and 9). Blood specimens from symptomatic individuals were tested for SARS-CoV-2 antibodies (weeks 10–12). *Limitations*: Study could not identify specific mechanisms for how mask interventions worked to reduce infections; conducted prior to emergence of the Delta variant.

Implications: A well-designed cluster-randomized trial found that even modest increases in community use of masks, particularly surgical masks, might effectively reduce symptomatic SARS-CoV-2 infections (COVID-19).

Testing

PEER-REVIEWED

Pooled RT-qPCR testing for SARS-CoV-2 surveillance in schools - a cluster randomised trial. Joachim *et al.* EClinical Medicine (August 25, 2021).

Key findings:

- Of 2,218 PCR tests conducted on 21,978 specimens, 41 (1.8%) pooled results were positive.
- Upon retesting of individual specimens, 36 students were identified to have SARS-CoV-2 infection.
    - 47% (17/36) of students with SARS-CoV-2 infection were identified in a single school.
- Number of SARS-CoV-2 infections in secondary schools identified did not differ by swab method.

Methods: In a study evaluating pooled SARS-CoV-2 PCR testing, 3,970 students at 14 schools in Germany were randomized to either oropharyngeal, buccal, or saliva swab specimen collection, 2–3 times/week for 3 weeks during November–December 2020. Specimens with positive pooled test results were retested individually the same day or the following day. *Limitations*: Volunteers not necessarily representative of the overall population; nasopharyngeal swabs were not assessed.

Implications: Conducting PCR tests on pooled specimens at least twice weekly might be a feasible way for schools to identify SARS-CoV-2 infections among students and apply timely isolation and quarantine measures.

Transmission Risks and Dynamics

PEER-REVIEWED

The effect of population mobility on COVID-19 incidence in 314 Latin American cities: a longitudinal ecological study with mobile phone location data. Kephart *et al.* The Lancet Digital Health (August 26, 2021).

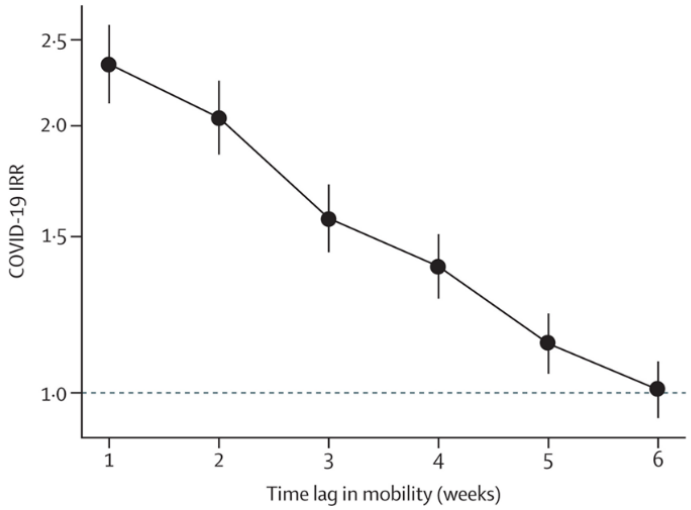
Key findings:

- Lower urban population mobility by 10% weekly was associated with 8.6% (95% CI 7.6%-9.6%) lower COVID-19 incidence locally in the following week.
- Overall COVID-19 incidence rate ratio (IRR) was 2.4 (95% CI 2.1-2.6) for each log unit increase in mobility during the previous week, compared to baseline (Figure).

Methods: Large ecological study using spatially aggregated mobile phone location data and daily confirmed COVID-19 case counts in 1,031 areas representing 314 cities with >100,000 inhabitants, in Argentina, Brazil, Columbia, Guatemala, and Mexico, at baseline (March 2–9, 2020) and during the study period (March 10–August 29, 2020). Longitudinal associations between weekly mobility and subsequent COVID-19 incidence were evaluated using binomial regression. *Limitations*: Confirmed cases likely under-reported; aggregate data did not include individual characteristics such as employment; study time period did not allow evaluation of seasonality.

Implications: Policies that reduce population mobility might be effective in reducing COVID-19 incidence, but should be combined with strategies and policies that seek to protect groups at higher risk of adverse social and economic costs.

Figure:



Note: Adapted from Kephart *et al*. Association between population mobility and COVID-19 incidence rate ratio (IRR) in 314 Latin American cities. Licensed under CC BY.

Health Equity

PREPRINTS (NOT PEER-REVIEWED)

Global disparities in SARS-CoV-2 genomic surveillance. Brito *et al.* medRxiv (August 26, 2021).

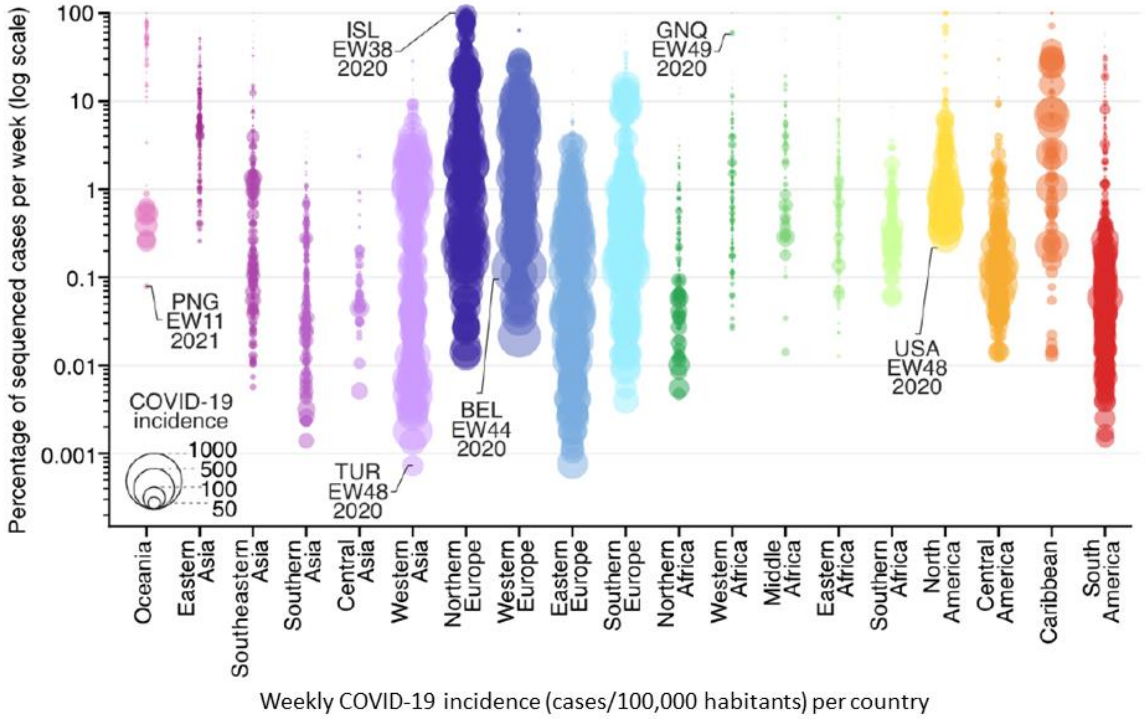
Key findings:

- Low- and middle-income countries (LMIC) have sequenced SARS-CoV-2 viral genomes from <0.5% of their confirmed COVID-19 cases, whereas many high-income (HIC) countries have been able to sequence >5%. (Figure)
- Some HIC performed near real-time surveillance (median turnaround time below 21 days), but turnaround times were longer in many LMIC (median 78 days).
- Countries sequencing smaller percentages of cases and fewer SARS-CoV-2 viral genomes detected less lineage diversity and fewer variants.

Methods: Descriptive analysis of metadata from >2,400,000 consensus genome sequences deposited in the Global Initiative on Sharing Avian Influenza Data (GISAID) during the first 15 months of the COVID-19 pandemic. Genomic surveillance disparities were assessed by frequency of genome sequencing, turnaround time, and variant detection in HIC and LMIC. *Limitations*: Data from publicly accessible genomic databases only.

Implications: Genome sequencing is important to understand SARS-CoV-2 virus evolution and equitably guide public health interventions as new variants emerge. Enhancing capacity to perform genomic surveillance in all geographic regions, including LMIC, might improve global public health.

Figure:



Note: Adapted from Brito *et al*. COVID-19 incidence and percentage of sequenced cases by world geographic region for each epidemiologic week (EW) between February 23, 2020 and March 27, 2021, based on metadata submitted to GISAID.
BEL = Belgium; GNQ = Equatorial Guinea; ISL = Iceland; PNG = Papua New Guinea; TUR = Turkey; USA = United States.
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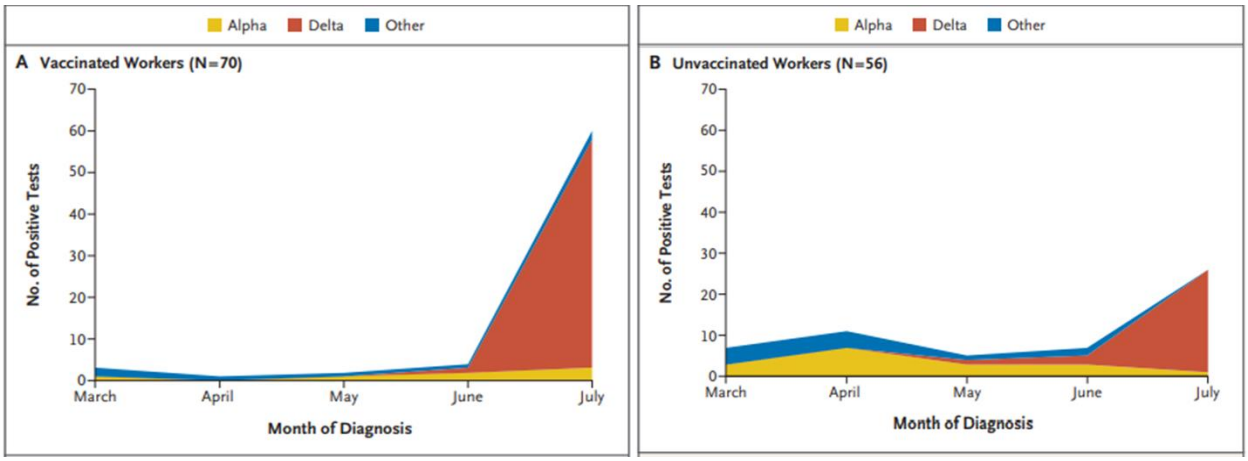
In Brief

Vaccines

- **Durability of antibody response to vaccination and surrogate neutralization of emerging variants based on SARS-CoV-2 exposure history**. McDade *et al.* Scientific Reports (August 30, 2021). In a serology study of 27 participants who received 2 COVID-19 vaccine doses (59.3% Comirnaty, Pfizer/BioNTech; 40.7% Moderna), spike-ACE2 binding inhibition for ancestral type SARS-CoV-2 virus was 97.7%, higher than for certain variants of concern: Alpha (B.1.1.7) 92.0%, Gamma (P.1) 70.0%, or Beta (B.1.351) 66.7%. Three months after 1st vaccine dose, median anti-RBD IgG antibody was higher for persons who had been symptomatic with a PCR-confirmed diagnosis of COVID-19 (27.2 µg/mL) compared to persons who were seronegative (8.7 µg/mL) and persons who had been asymptomatic yet seropositive (8.2 µg/mL).

Variants

- **Resurgence of SARS-CoV-2 infection in a highly vaccinated health system workforce**. Keehner *et al.* NEJM (September 1, 2021). Among 19,000 healthcare workers (HCWs) in an academic health care system in California, 227 had positive RT-PCR test results for SARS-CoV-2 in March–July 2021 and 57.3% had been fully vaccinated. The steepest increases coincided with the end of the state's mask mandate and the emergence of the Delta variant. Vaccine effectiveness against symptomatic infection decreased from ≥93.9% in March–June to 65.5% in July. Attack rate was 6.7/1,000 persons vaccinated in January–February 2021, and 3.7/1,000 persons vaccinated in March–May.

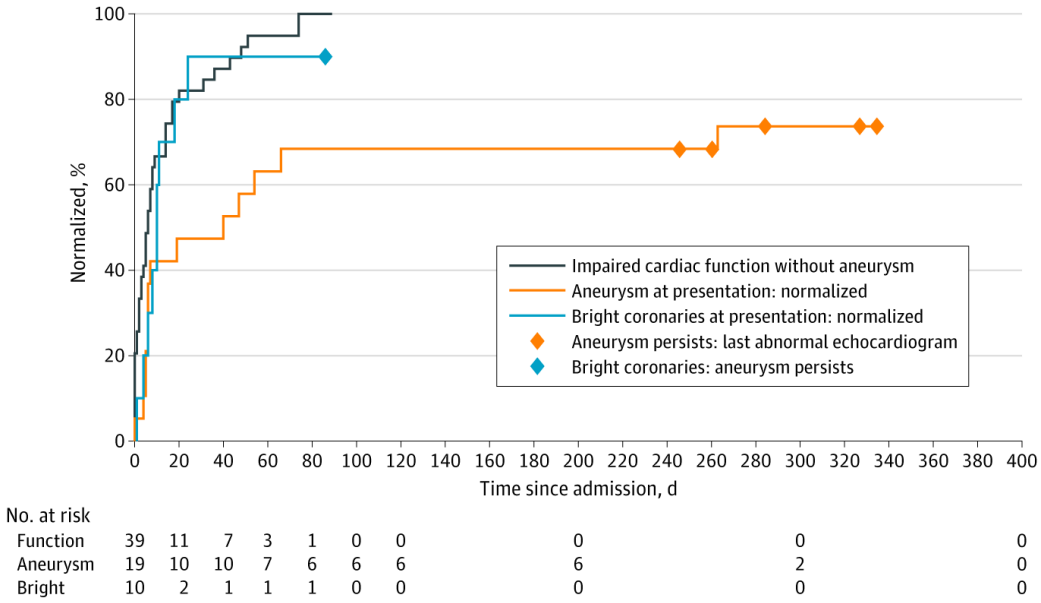


Note: Adapted from Keehner *et al.* Distribution of **Alpha (B.1.1.7),** **Delta (B. 1.617.2),** and **other SARS-CoV-2 variants** by month of diagnosis, among **A)** vaccinated healthcare workers, or **B)** unvaccinated healthcare workers. N is healthcare workers who were symptomatic and had available variant data. From the New England Journal of Medicine, Keehner *et al.*, Resurgence of SARS-CoV-2 infection in a highly vaccinated health system workforce. September 1, 2021, online ahead of print. Copyright © 2021 Massachusetts Medical Society. Reprinted with permission from Massachusetts Medical Society.

Natural History, Reinfection, and Health Impact

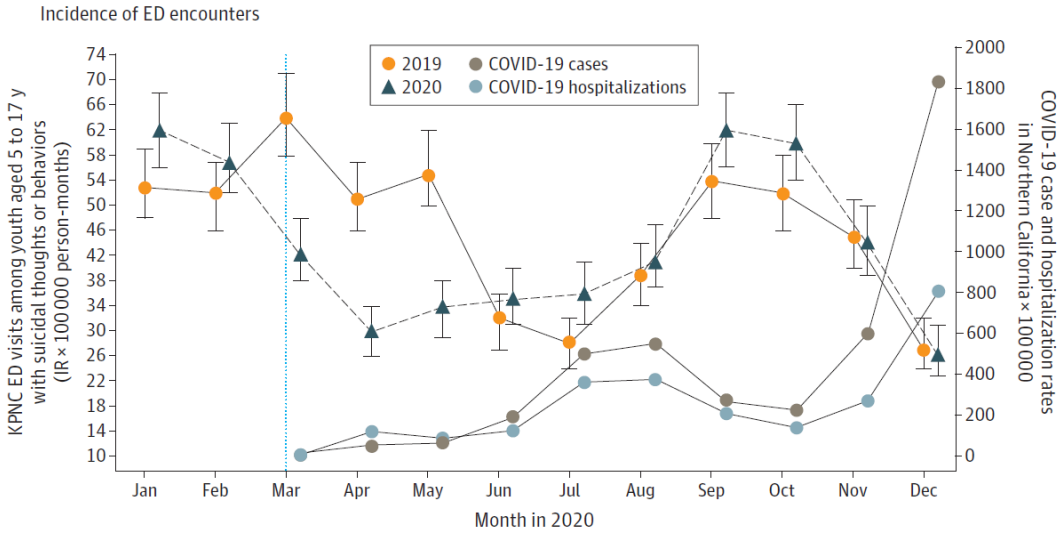
- **1-year outcomes in hospital survivors with COVID-19: a longitudinal cohort study**. Huang *et al.* The Lancet (August 26, 2021). Among 1,276 adults (median age 59 years; 53% male) surviving for 1 year after hospitalization for COVID-19 in Wuhan, China, those with any sequelae decreased from 68% at 6 months to 49% at 12 months following symptom onset (p<0.0001). Persistent symptoms at 1 year were most commonly fatigue or muscle weakness (20%), sleep difficulties (17%), joint pain (12%), and hair loss (11%). Although 88% of employed survivors had returned to work by 1 year, they had worse health status compared with community-dwelling adults without SARS-CoV-2 infection matched for age, sex, and comorbidities. Among survivors who had been critically ill (required high-flow oxygen or ventilation), lung diffusion impairment was still observed at 1 year in 54%.

- **One-year outcomes of critical care patients post–COVID-19 multisystem inflammatory syndrome in children**. Davies *et al.* JAMA Pediatrics (August 31, 2021). Among 68 pediatric patients followed for 1 year after hospitalization for pediatric inflammatory multisystem syndrome temporally associated with SARS-CoV-2 (PIMS-TS) or multisystem inflammatory syndrome in children (MIS-C) in the United Kingdom, most children recovered with no long-term sequelae and none died. When tested more than 50 days postadmission, ≥97% of their blood test results were normal. However, 6 (9%) children had ongoing echocardiographic abnormalities with aneurysmal changes, and 2 (3%) children had critical care readmissions for other reasons.



Note: Adapted from Davies *et al*. Time to first evidence of normalization in children after hospital admission for PIMS-TS or MIS-C with echocardiographic evidence of **impaired cardiac function**, **aneurysms**, or **bright coronaries**. Diamonds represent patients with no evidence of normalization at the time of their last abnormal echocardiogram. Reproduced with permission from JAMA Pediatrics, 2021. Published online August 31, 2021. https://doi.org/10.1001/jamapediatrics.2021.2993. Copyright© 2021 American Medical Association. All rights reserved.

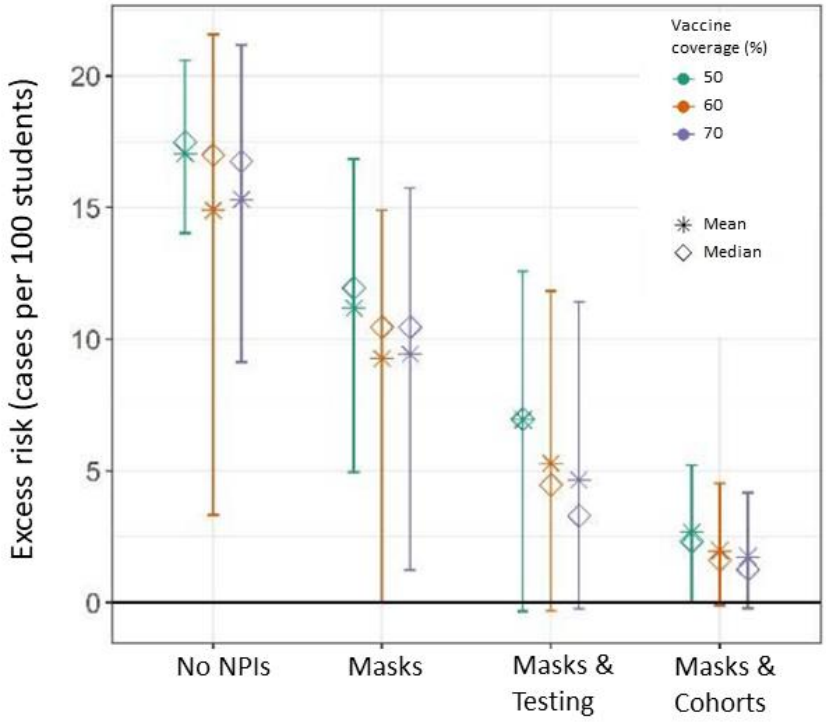
- **Emergency department encounters among youth with suicidal thoughts or behaviors during the COVID-19 pandemic**. Ridout *et al.* JAMA Psychiatry (September 1, 2021). Emergency department (ED) encounters among youth aged 5–17 years experiencing suicidal thoughts and behaviors were evaluated before and during the COVID-19 pandemic using electronic health records from a health maintenance organization in California. After a decrease in early 2020 possibly attributable to shelter-in-place orders, population-level incidence rate ratios of suicide-related ED encounters among youth during the COVID-19 pandemic in 2020 were similar to pre-pandemic levels in 2019.



Note: Adapted from Ridout *et al*. Incidence of suicide-related emergency department encounters was similar **before** and **during** the COVID-19 pandemic among youth aged 5–17 years. COVID-19 cases and hospitalizations also shown. Reproduced with permission from JAMA Psychiatry, 2021. Published online September 1, 2021. https://doi.org/10.1001/jamapsychiatry.2021.2457. Copyright© 2021 American Medical Association. All rights reserved.

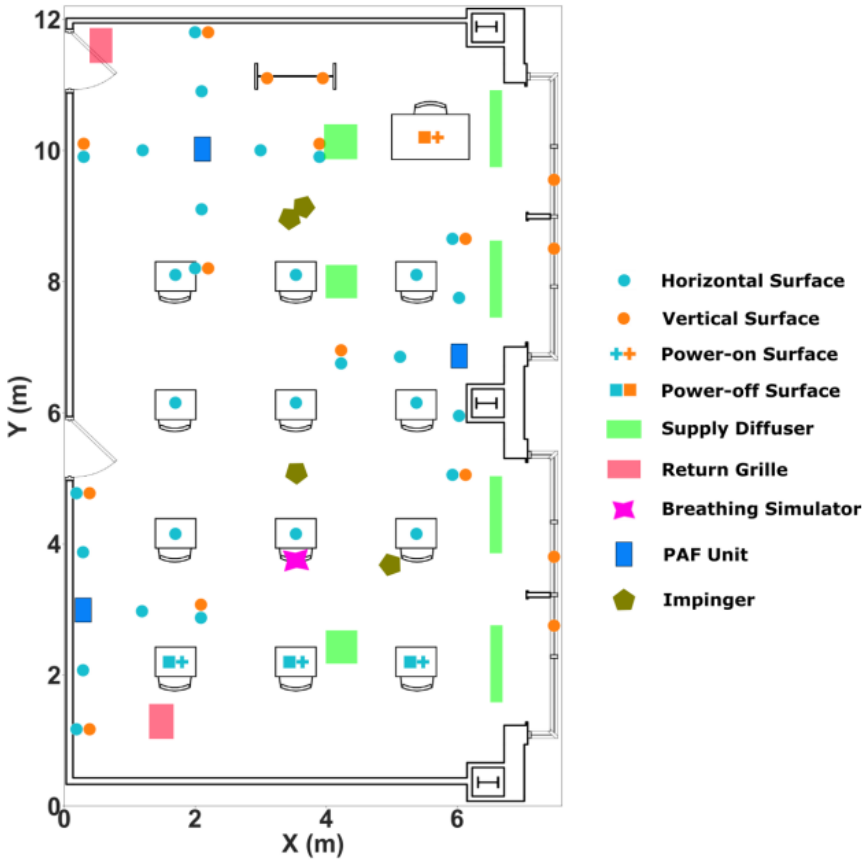
Prevention Strategies and Non-Pharmaceutical Interventions

- **Model-based assessment of SARS-CoV-2 Delta variant transmission dynamics within partially vaccinated K-12 school populations**. Head *et al.* medRxiv (Preprint; August 23, 2021). **Published in The Lancet Regional Health – Americas (November 25, 2021).** An individual-based transmission model used data from spring 2021 to predict Delta variant transmission attributable to within-school transmission at a 380-person elementary school, a 420-person middle school, and a 620-person high school. In a high-risk scenario assuming no mask use or cohorts and only 50% community vaccination coverage, excess COVID-19 cases could occur among 33–69 elementary school students, 53 middle school students, and 65 high-school students over a 4-month semester. In a different scenario assuming universal mask use, cohorts, and 60% community vaccination coverage, excess COVID-19 cases could occur among 2–7 elementary school students, 3 middle school students, and 1 high school student over the 4-month semester. Layering non-pharmaceutical interventions (NPIs) and/or increasing vaccination coverage could reduce school transmission; universal masking in schools might prevent more COVID-19 cases than masking only for unvaccinated persons.



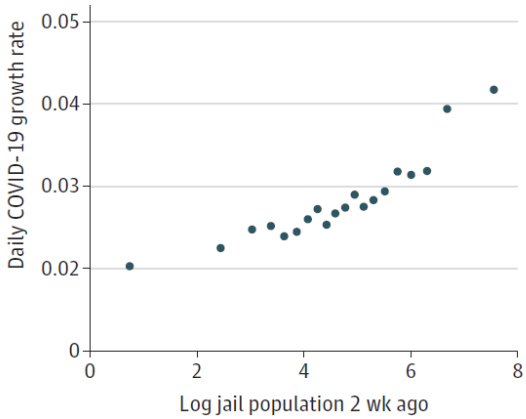
Note: Adapted from Head *et al*. Excess COVID-19 cases per 100 elementary school students attributable to within-school transmission across 1,000 model realizations, by non-pharmaceutical interventions (none; universal masks; masks and testing; masks and cohorts) for three levels of community vaccination coverage (**50%, 60%,** or **70%**). Vertical lines show the 89th percentile high probability density interval. Licensed under CC-BY-ND 4.0.

- **Localized and whole-room effects of portable air filtration units on aerosol particle deposition and concentration in a classroom environment**. Kong *et al.* medRxiv (Preprint; August 30, 2021). **Published in ACS ES&T Engineering (February 17, 2022).** In a mock classroom with a breathing simulator, an investigation of particle air filtration (PAF) units as a supplement to background ventilation systems found that PAF units could reduce air particle concentrations by a factor of 2.5 and reduce particle deposition on horizontal surfaces (e.g., classroom desks). Air cleaners like PAF units might be useful engineering controls to mitigate direct and indirect aerosol transmission as part of a multi-layered strategy to reduce risks from SARS-CoV-2 and other respiratory viruses in indoor environments.



Note: Adapted from Kong *et al.* Schematic diagram of the classroom environment. PAF = portable air filtration unit. Used by permission of authors.

- **Association of jail decarceration and anticontagion policies with COVID-19 case growth rates in U.S. counties**. Reinhart *et al.* JAMA Network Open (September 2, 2021). Regression models using data from 1,605 counties representing 72% of the U.S. population predicted that reducing numbers of people in jails, prisons, and immigrant detention facilities by 80% (large-scale decarceration) would lower COVID-19 case growth rates by 2% daily, with larger decreases in counties with above-median population density and above-median proportion of Black residents. In these models, daily COVID-19 growth rates were also slowed by nursing home visitation bans (7.3%), school closures (4.3%), mask mandates (2.5%), prison visitation bans (1.2%), and stay-at-home orders (0.8%), but not other policy interventions.



Note: Adapted from Reinhart *et al.* Association between recent jail population size and daily COVID-19 growth rate, controlling for county-level fixed effects such as demographics, socioeconomic status, culture, and health systems. Licensed under CC BY.

Testing

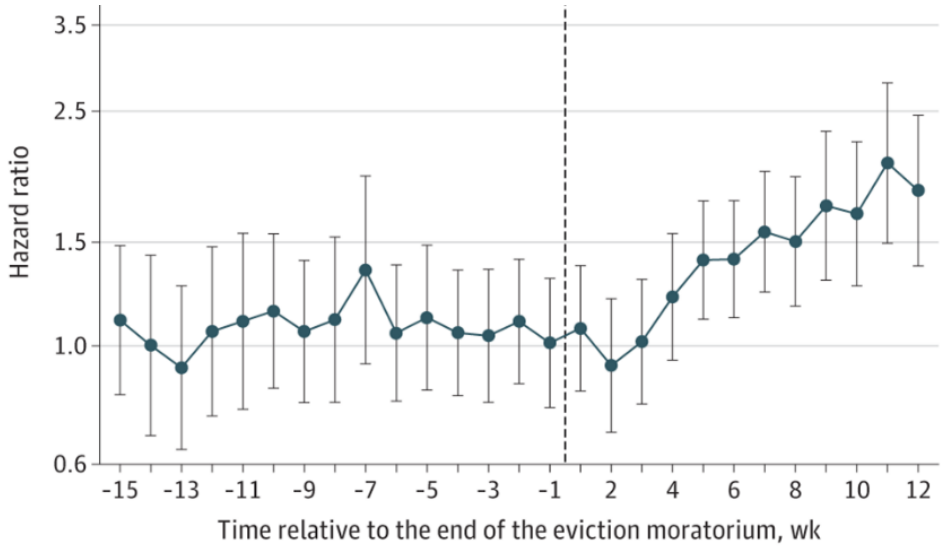
- **Validation of an at-home direct antigen rapid test for COVID-19**. Harmon *et al.* JAMA Network Open (August 27, 2021). Among 257 study participants in Massachusetts who used inexpensive direct antigen rapid tests (DARTs) for high-frequency (twice weekly for 6 months) at-home SARS-CoV-2 testing of self-collected nasal swabs, DART detected 100% (15/15) of SARS-CoV-2 infections detected by RT-PCR co-testing. Compared to RT-PCR, sensitivity of DART was 78.9% (95% CI 69.1%-88.8%), and specificity was 97.1% (95% CI 96.3%-97.8%) for SARS-CoV-2 detection within 12 days after symptom onset.

- **Evaluation of allocation schemes of COVID-19 testing resources in a community-based door-to-door testing program**. Chugg *et al.* JAMA Health Forum (August 27, 2021). A community-based door-to-door SARS-CoV-2 testing program by community health workers (*promotores de salud*) in San Jose, California, during December 2020–February 2021, reached significantly higher proportions of Latinx individuals (87.6% vs. 30.7%–49.0%), women (61.1% vs. 50.5%–51.9%) and persons aged ≥65 years (12.7% vs. 5.4%–7.8%) than neighborhood testing sites. Overall RT-PCR positivity among 756 participants was 6.8%. Response rates (fraction of visits with ≥1 test) were highest when sampling protocol was based on local knowledge (50.5%) or uncertainty sampling (23.4%) rather than index area selection (10.7%).

Health Equity

- **Racial/ethnic differences in COVID-19 vaccine hesitancy among health care workers in 2 large academic hospitals**. Momplaisir *et al.* JAMA Network Open (August 30, 2021). In a survey of 10,871 healthcare workers (HCWs) at 2 major Philadelphia hospitals conducted prior to widespread COVID-19 vaccine availability (November–December 2020), 50.0% indicated vaccine hesitancy. Reasons given for hesitancy were concerns about side effects (87.1%), newness of the vaccine (79.2%), not knowing enough about the vaccine (75.2%), the chance that it may not work (28.2%), and concerns about becoming infected by receiving the vaccine (21.5%). Compared with White HCWs, hesitancy was significantly more common among Black HCWs (adjusted odds ratio [aOR] 4.98, 95% CI 4.11-6.03), Hispanic or Latino HCWs (aOR 2.10, 95% CI 1.63-2.70), other or mixed race/ethnicity HCWs (aOR 1.48, 95% CI 1.21-1.82) and Asian HCWs (aOR 1.47, 95% CI 1.26-1.71).

- **Eviction moratoria expiration and COVID-19 infection risk across strata of health and socioeconomic status in the United States**. Sandoval-Olascoaga *et al.* JAMA Network Open (August 30, 2021). A cohort study of 509,694 people living in the United States found that in 18 states that lifted eviction moratoria, COVID-19 risk was higher in the following 12 weeks than in 26 states that maintained moratoria (adjusted hazard ratio [aHR] 1.83, 95% CI 1.36-2.46). COVID-19 risk was further increased among people with preexisting medical comorbidities (aHR 2.37, 95% CI 1.67-3.36) and people living in nonaffluent and rent-burdened areas (aHR 2.14, 95% CI 1.51-3.05).



Note: Adapted from Sandoval-Olascoaga *et al.* Hazard ratio for COVID-19 in states that lifted eviction moratoria compared to states that maintained eviction moratoria from March–September 2020, with 95% confidence intervals. Dashed vertical line shows when evictions began. Licensed under CC BY.

From the *Morbidity and Mortality Weekly Report* (September 10, 2021).

- Long-Term Symptoms Among Adults Tested for SARS-CoV-2 — United States, January 2020–April 2021
- Using Wastewater Surveillance Data to Support the COVID-19 Response — United States, 2020–2021
- SARS-CoV-2 Transmission to Masked and Unmasked Close Contacts of University Students with COVID-19 — St. Louis, Missouri, January–May 2021
- Trends in COVID-19 Cases, Emergency Department Visits, and Hospital Admissions Among Children and Adolescents Aged 0–17 Years — United States, August 2020–August 2021
- Hospitalizations Associated with COVID-19 Among Children and Adolescents — COVID-NET, 14 States, March 1, 2020–August 14, 2021

Disclaimer: The purpose of the CDC COVID-19 Science Update is to share public health articles with public health agencies and departments for informational and educational purposes. Materials listed in this Science Update are selected to provide awareness of relevant public health literature. A material's inclusion and the material itself provided here in full or in part, does not necessarily represent the views of the U.S. Department of Health and Human Services or the CDC, nor does it necessarily imply endorsement of methods or findings. While much of the COVID-19 literature is open access or otherwise freely available, it is the responsibility of the third-party user to determine whether any intellectual property rights govern the use of materials in this Science Update prior to use or distribution. Findings are based on research available at the time of this publication and may be subject to change.