The SARS-CoV-2 pandemic has impacted the medical, economic, social, and political landscape worldwide. Despite public health measures to contain the virus, including masks, hand hygiene, school closures, and stay-at-home orders, COVID-19 was the third leading cause of death in the US in 2020. Although early data suggested that children accounted for only 2% of COVID-19 cases, more recent reports have indicated that 13% of diagnosed cases in the US have occurred in children. Additionally, the number of COVID-19 hospitalizations among children is similar to that observed in a typical influenza season, and COVID-19 deaths in children exceed the total observed in any single influenza season. In March 2020, in an attempt to curb the exponential growth of the COVID-19 pandemic, kindergarten through 12th-grade schools closed in all 50 US states, affecting 57 million students. The effects of these school closures have been far reaching, including marked social disruption and psychological and educational impact. Nevertheless, the resumption of in-person learning has proven controversial, as officials and communities weigh the risks of potential transmission of SARS-CoV-2 in schools against the benefits of in-person learning. To adequately assess these risks, it is important to address 3 key questions: (1) What is the role of children in community transmission of infectious pathogens? (2) What is the role of children specifically in SARS-CoV-2 transmission? and (3) What can be done to get children safely back in daycare, preschool, and school?

In addressing the first question, it is critical to recognize that interacting with children carries inherent exposure to and risk of infectious diseases for daycare workers, teachers, parents, or grandparents. Children play a large role in community transmission of multiple infectious pathogens, including hepatitis A, respiratory syncytial virus, cytomegalovirus, influenza, rotavirus, and invasive pneumococcal disease. For some of these pathogens, the extent of child-to-adult transmission was identified only after pediatric vaccination affected adult disease burden. Closure of schools and stay-at-home orders in the spring of 2020 had a marked impact on respiratory syncytial virus and influenza community transmission well before masking was routinely recommended. These observations have provided a framework to understand how the home, school, and community interface to influence transmission dynamics of infectious diseases. In this way, they have also helped inform strategies to mitigate transmission of SARS-CoV-2.

So what is known about the role of children in transmission of SARS-CoV-2 to other children and to adults? Transmission likely depends on multiple factors, including symptoms (ie, type, severity, and duration), the duration and timing of exposure (ie, presymptomatic or symptomatic), the amount of virus in the infected individual (viral load), the viral variant (eg, B.1.1.7), and host factors, such as baseline susceptibility and immune responses in the exposed individual. Furthermore, the risk of developing symptoms (eg, COVID-19) once infected with SARS-CoV-2 may depend on host factors, including age and comorbidities. Any such factors may differ between children and adults. Thus, determining the role of children in the transmission of SARS-CoV-2 is challenging.

Chung et al performed a cross-sectional, countywide, community-based surveillance study in King County, Washington, of SARS-CoV-2 symptoms and viral RNA levels among children and adults. The authors analyzed more than 37 000 nasal swab samples to identify 123 children and 432 adults with SARS-CoV-2 infection. They found that children were less frequently symptomatic (61.8% of children vs 92.8% of adults), had fewer symptoms (mean [SD], 3.8 [3.8] among children vs 4.9 [4.1] among adults), and had shorter duration of symptoms (mean [SD], 3.8 [3.8] among children vs 4.9 [4.1] among adults). Compared with asymptomatic individuals, symptomatic individuals had lower SARS-CoV-2 cycle threshold (Ct) values, which corresponds to higher viral RNA levels. Importantly, there was no difference in Ct values between symptomatic children and symptomatic adults, nor between asymptomatic children and asymptomatic adults. Although viral RNA levels were measured using Ct values, which are a semiquantitative surrogate of viral load, a recent study demonstrated correlation between both Ct values and RNA viral loads with cultivable SARS-CoV-2 virus from the nasopharynx. These data corroborate recent studies of asymptomatic children and studies of viral load by age. To put these data into the context of transmission risk, a recent study demonstrated that SARS-CoV-2 Ct values almost linearly inversely correlated with transmission. Furthermore, a meta-analysis found that the risk of asymptomatic transmission is significantly lower than that of symptomatic transmission (relative risk, 0.58; 95% CI, 0.34-0.99; P = .047). Taken together, these findings suggest that children may be less likely to transmit SARS-CoV-2 because of reduced frequency and severity of symptoms, which are associated with reduced viral load.

While the relative risk of transmission from children with SARS-CoV-2 infection remains uncertain, it is clear that children can transmit the virus. Early data from a study in South Korea suggested that children older than 10 years had a high risk of transmitting COVID-19. Subsequent studies have indicated a low but appreciable SARS-CoV-2 transmission risk from children. In a meta-analysis of household transmission dynam-
ics, 3.8% of transmission clusters had a pediatric index case, and secondary infection rates of pediatric household contacts were lower than adult household contacts (relative risk, 0.62; 95% CI, 0.42-0.91). In schools, transmission typically follows trends in community transmission, rather than preceding or augmenting them. Schools have not been associated with frequent outbreaks or substantial increases in community transmission as measured by COVID-19-associated hospitalizations. Recent data demonstrate that although the risk of COVID-19 is greater among children who are attending school in person, this risk disappears with layered prevention measures. The collective implications of these studies are that children appear to be less likely to transmit SARS-CoV-2 than adults, and that transmission in schools can be mitigated.

What then can be done to get kids back to daycare, preschool, and school safely? Our increasing understanding of transmission dynamics among children inform decisions about in-person learning. The US Centers for Disease Control and Prevention emphasizes that kindergartens through 12th-grade schools can resume in-person learning through phased reopening, and prioritization of the correct and consistent use of masks and physical distancing. Layering prevention strategies, including teacher masking, daily symptom screens, and appropriate isolation and quarantine, further reduces transmission risk in schools. The study by Chung et al underscores the potential transmission risk of symptomatic children and the importance of isolating while symptomatic. Keeping symptomatic children home would have benefits for prevention not only of SARS-CoV-2, but also of influenza, respiratory syncytial virus, and other infectious pathogens. Additionally, extracurricular activities are important in SARS-CoV-2 transmission, and measures to prevent transmission should be used.

Finally, to get back to something resembling the normal life of 2019, vaccination of children is needed. As has been observed for other pathogens, local vaccine hesitancy can result in sustained transmission of vaccine-preventable infections. Without vaccination, children will continue to serve as a reservoir of SARS-CoV-2 infections, experiencing preventable morbidity and delaying the development of herd immunity. The Pfizer-BioNTech BNT162b2 vaccine has received emergency use authorization by the US Federal Drug Administration (FDA) for administration to adults and adolescents 12 years and older, and Moderna has released data demonstrating the safety and efficacy of its vaccine (mRNA-1273) for adolescents 12 years and older. Clinical trials are also underway to assess the safety and immunogenicity of BNT162b2 and mRNA-1273 for children 6 months and older (NCT04816643 and NCT04796896, respectively). Expanding vaccine eligibility for children and addressing vaccine hesitancy will provide greater opportunities to layer protection and reduce transmission risk in schools. Additionally, encouraging uptake of vaccines among educators and school staff is critical to reduce their risk of occupational acquisition (eg, from children or other staff) and transmission of SARS-CoV-2 to others. As in-school transmission events parallel community transmission, we must all remain vigilant in our commitment to public health prevention strategies, flexible in our approach to an evolving virus, and resilient in our efforts to safely provide the best learning opportunities for our children.

REFERENCES


5. Anderson EJ, Daugherty MA, Pickering LK, and Sanofi Pasteur for consulting; his institution receives funds to conduct clinical research unrelated to this article from MedImmune, Regeneron, Paxvax, Pfizer, GSK, Merck, Novavax, Sanofi Pasteur, Janssen, and Micron; he serves on a safety monitoring board for Sanofi Pasteur and Kentucky BioProcessing, Inc; and he reports support from the National Institutes of Health to conduct COVID-19 vaccine and other vaccine clinical trials, paid to his institution.


