The following information resources have been selected by the National Health Library and Knowledge Service Evidence Virtual Team in response to a question from the National Immunisation Advisory Committee (NIAC). The resources are listed in our estimated order of relevance to practicing healthcare professionals confronted with this scenario in an Irish context. In respect of the evolving global situation and rapidly changing evidence base, it is advised to use hyperlinked sources in this document to ensure that the information you are disseminating to the public or applying in clinical practice is the most current, valid and accurate. For further information on the methodology used in the compilation of this document—including a complete list of sources consulted—please see our National Health Library and Knowledge Service Summary of Evidence Protocol.

Question 216

In which settings is SARS-CoV-2 transmitted among the adolescent population?

Main Points

1. Children and adolescents are susceptible to and can transmit SARS-CoV-2. Incidence of symptomatic infection increases with increasing age. Adolescents seem to be more susceptible to becoming infected than younger children. Adolescents also transmit the infection to a greater extent than younger children.
2. Viral loads and the risk of transmission appear to be greater in symptomatic than in asymptomatic individuals.
3. Household contact studies have identified variable rates of transmission from child and adolescent index cases. The variable rates may be related to different community prevalence and mitigation measures, methods of diagnosing secondary cases, timing of sample collection, and levels of adherence to infection control measures in the home.
4. There is limited high-quality evidence to quantify the extent of transmission in early, primary, secondary and tertiary education settings, with a general consensus emerging that the decision to close schools to control the COVID-19 pandemic should be used as a last resort. The American Academy of Pediatrics (AAP) asserts that the benefits of in-person school outweigh the risks in almost all circumstances; and that remote learning highlighted inequities in education, was detrimental to the educational attainment of

students of all ages, and exacerbated the mental health crisis among children and adolescents.

5. **Decisions about participation in sports and extracurricular activities for children should be made on a case-by-case basis. Factors to consider include the ability to maintain mitigation measures and whether activities increase the risk of transmission.**
6. **Indoor sports, close contact team sports and intense exercise have been associated with increased transmission. Social gatherings associated with team sports may also increase the risk of transmission.**

Summary of Evidence

Children and adolescents are susceptible to and can transmit SARS-CoV-2[2], with evidence to date suggesting that incidence increases with increasing age[2, 8]. Viner et al[13] report that children and adolescents have lower susceptibility to SARS-CoV-2, with an odds ratio of 0.56 for being an infected contact compared with adults, and play a lesser role than adults in transmission of SARS-CoV-2 at a population level. Adolescents seem to be more susceptible to becoming infected than younger children[6]. Adolescents also transmit the infection to a greater extent than younger children[2, 6]. Viral loads and the risk of transmission appear to be greater in symptomatic than in asymptomatic individuals[8].

The European Centre for Disease Prevention and Control (ECDC) report that pooled data from over 16 million case-based records from 16 countries up to 20 June 2021 show that in the peak of COVID-19 that started in March 2021, case notification rates in adolescents aged 16-18 years increased the most sharply, and have since remained the highest rate seen among all age-groups. The trend for this age-group is mirrored most closely by rates in adolescents aged 12-15 years. Increased incidence was less steep and/or started later among other paediatric age-groups, with decreasing age leading to shallower gradients and lower peak rates[2].

Household contact studies have identified variable rates of transmission from child and adolescent index cases. In some studies, transmission from children to household contacts is infrequent; in other studies, rates of transmission from children to household contacts are similar to or higher than those in adults. The variable rates may be related to different community prevalence and mitigation measures, methods of diagnosing secondary cases, timing of sample collection, and levels of adherence to infection control measures in the home[8].

There is limited high-quality evidence to quantify the extent of transmission in childcare, school and university settings, or to compare it with community transmission. However, emerging evidence suggests a lower overall infection attack rate in students (0.15%) compared with school staff (0.7%)[7, 12].

The general consensus remains that the decision to close schools to control the COVID-19 pandemic should be used as a last resort. The negative physical, mental and educational impacts of proactive school closures on children as well as the economic impact on society would likely outweigh the benefits[2]. Transmission of SARS-CoV-2 in school settings depends on local transmission rates; the types of variants circulating; the epidemiology of COVID-19 among children, adolescents, and staff; vaccine coverage for those eligible; and mitigation measures in place to prevent transmission[1]. When community rates of COVID-19 are high, there is an increased likelihood that SARS-CoV-2 will be introduced to and potentially transmitted within schools. Evidence to date suggests that when prevention strategies are layered and implemented with fidelity, transmission within schools can be limited. In light of circulating SARS-CoV-2 variants of concern, including Delta, combinations of non-pharmaceutical interventions will continue to be essential to prevent transmission in school settings[2].

The American Academy of Pediatrics (AAP) asserts that the benefits of in-person school outweigh the risks in almost all circumstances; and that remote learning highlighted inequities in education, was detrimental to the educational attainment of students of all ages, and exacerbated the mental health crisis among children and adolescents[5]. In the United States and other countries, resumption of in-person primary and secondary education before the emergence of more transmissible variants was associated with relatively few reports of school outbreaks when mitigation strategies were in place[8]. Walsh et al[18] point out that school closure studies may be at risk of confounding and collinearity from other non-pharmacological interventions implemented around the same time, and that the effectiveness of school closures remains uncertain. School re-openings in areas of low transmission and with

appropriate mitigation measures were generally not accompanied by increasing community transmission.

Decisions about participation in sports and extracurricular activities for children should be made on a case-by-case basis. Factors to consider include the ability to maintain mitigation measures and whether activities increase the risk of transmission among students or staff: eg resulting in or requiring deep breathing such as intense exercise, shouting, or singing[10].

Indoor sports, close contact team sports and intense exercise have been associated with increased transmission. Social gatherings associated with team sports may also increase the risk of transmission[10].

Irish and/or International Guidance

Level 1

Centers for Disease Control and Prevention (United States) (2021) Science Brief: Transmission of SARS-CoV-2 in K-12 Schools and Early Care and Education Programs – Updated[1]

Among the updates included in the July 9, 2021 CDC science briefing document were:

- ☐ modifications to the BACKGROUND section to reflect the current state of the pandemic and to clarify that studies in the review pre-date the approval of vaccinations for adults and adolescents 12 years and older
- ☐ condensed and updated information in the section COVID-19 IN CHILDREN AND ADOLESCENTS
- ☐ an added section on EARLY CARE AND EDUCATION SETTINGS
- ☐ added information on the updated *CDC Guidance for COVID-19 Prevention in Kindergarten (K)-12 Schools and COVID-19 Guidance for Operating Early Care and Education/Child Care Programs*

Schools and early care and education (ECE) programs are an important part of the infrastructure of communities. They provide safe, supportive learning environments for children and adolescents, and employ teachers and other staff. Schools and some ECE programs also provide critical services including school meal programs and social, physical, behavioral and mental health services. Schools and ECE programs have other benefits for the community including enabling parents, guardians and caregivers to work. In the spring of 2020, kindergarten to grade 12 (K-12) schools and many ECE programs in the United States closed for in-person instruction or care

[1] Centre for Disease Control and Prevention (2021) Science Brief: Transmission of SARS-CoV-2 in K-12 Schools and Early Care and Education Programs – Updated, https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/transmission_k_12_schools.html

as a strategy to slow the spread of SARS-CoV-2. Reports suggest that the limited in-person instruction during the pandemic may have had a negative effect on learning for children and on the mental and emotional well-being of both parents and children. For schools and ECE programs, the benefits of in-person school and caregiving need to be balanced against the risk of acquiring and spreading SARS-CoV-2 in these settings.

Globally, K-12 schools and ECE programs used various, layered COVID-19 prevention strategies with in-person, hybrid and virtual models of instruction and care during the 2020/'21 academic year. Their experiences have contributed to our knowledge of the nature of SARS-CoV-2 transmission in schools, ECE programs and their surrounding communities.

Given the rapid developments of the pandemic response and the time needed to collect, analyze and report new data, the studies in this updated science brief primarily describe experiences before widespread availability of COVID-19 vaccines. The availability of safe and effective vaccines for people ages 12 years and older and subsequent decreases in COVID-19 cases, hospitalizations and deaths mark progress against COVID-19. Increasing COVID-19 vaccination rates will likely affect patterns of transmission in schools and communities. As of July 4, 2021, approximately 55% of those 12 years and older in the United States were fully vaccinated.

In addition, the studies in this review describe school operations when multiple, layered prevention strategies were in use including universal masking policies, limited class sizes, and cohorting. Many state and local agencies are planning to or already have reduced prevention strategies such as physical distancing and masking for community settings including schools. Therefore, the 2021/'22 school year will not be directly comparable to the 2020/'21 school year. Evaluation and sharing of the 2021/'22 experiences will be needed to understand SARS-CoV-2 transmission risk in this new stage of the pandemic and to add to the science on the topic. Regardless, it has been established, as described by the evidence in this document, that layered COVID-19 prevention strategies help to prevent SARS-CoV-2 transmission.

Transmission of SARS-CoV-2 in schools and ECE programs depends on local transmission rates; the types of variants circulating; the epidemiology of COVID-19 among children, adolescents, and staff; vaccine coverage for those eligible; and mitigation measures in place to prevent transmission.

See Section: CONCLUSIONS

SARS-CoV-2 transmission in the community is correlated with the amount of infections in schools. When community rates of COVID-19 are high, there is an increased likelihood that SARS-CoV-2 will be introduced to and potentially transmitted within schools or ECE settings.

Evidence to date suggests that when prevention strategies are layered and implemented with fidelity, transmission within schools and ECE programs can be limited. Information on transmission patterns following the uptake of COVID-19 vaccines and the experiences of schools as they use different mixes of effective prevention strategies to address COVID-19 will help refine guidance.

Reducing SARS-CoV-2 transmission in schools and ECE programs is a shared responsibility. Schools and ECE programs can limit transmission by layering the following effective prevention strategies:

- ☐ promoting COVID-19 vaccination for those eligible
- ☐ consistent and correct use of masks by people who are not fully vaccinated
- ☐ physical distancing among people who are not fully vaccinated
- ☐ screening testing in K-12 schools
- ☐ improving ventilation
- ☐ handwashing and respiratory etiquette
- ☐ staying home when sick and getting tested
- ☐ testing and contact tracing in combination with isolation and quarantine
- ☐ routine cleaning with disinfection under certain conditions

Implementing these strategies is particularly important in areas with moderate, substantial or high transmission rates and low vaccination coverage in order to protect people who are not fully vaccinated. The CDC has developed guidance that administrators in K-12 schools and ECE programs can use to help protect students, teachers and staff; slow the spread of SARS-CoV-2; and support in-person learning and care.

Level 1

European Centre for Disease Prevention and Control (2021) COVID-19 in children and the role of school settings in transmission. Second update[2]

Increased transmissibility across all age-groups has been reported for SARS-CoV-2 variants of concern (VOCs), most notably for the Delta variant. In regions where an increasing percentage of adults are fully vaccinated against COVID-19 but where children are not vaccinated, it may be anticipated that in the coming months increasingly greater proportions of reported SARS-CoV-2 cases will be among children.

The majority of the studies referred to in this report were conducted prior to the emergence and widespread circulation of the Delta variant. This should be taken into account when interpreting reported study results.

Children of all ages are susceptible to and can transmit SARS-CoV-2. Cases of SARS-CoV-2 in younger children appear to lead to onward transmission less frequently than cases in older children and adults. Recent increases in the share of reported cases among children probably represents increased case ascertainment of mild cases. According to surveillance data, children aged 1-18 years have much lower rates of hospitalization, severe disease requiring intensive hospital care and death than all other age-groups. The exact burden of COVID-19 and its long-term consequences in the paediatric

[2] European Centre for Disease Prevention and Control (2021_ COVID-19 in children and the role of school settings in transmission - second update https://www.ecdc.europa.eu/en/publications-data/children-and-school-settings-covid-19-transmission

population is still to be determined and is a priority for further research.

The general consensus remains that the decision to close schools to control the COVID-19 pandemic should be used as a last resort. The negative physical, mental and educational impacts of proactive school closures on children as well as the economic impact on society would likely outweigh the benefits. Given the continued risk of transmission among unvaccinated children, it is imperative that there is a high level of preparedness in the educational system for the 2021/'22 school year.

In light of circulating SARS-CoV-2 VOCs, including Delta, combinations of non-pharmaceutical interventions in the form of physical distancing, hygiene and other measures will continue to be essential to prevent transmission in school settings. Measures should be adapted to levels of community SARS-CoV-2 transmission as well as to the educational setting and age-group. Implementation of measures should consider the need to provide children with an optimal learning and social environment while also reducing transmission risk.

It is important that strategies for educational settings aiming at timely testing of symptomatic cases are established to ensure isolation of cases and tracing and quarantine of their contacts. When positive cases are identified, the school should be informed, contact tracing should be initiated according to local guidelines, and communication to and the testing of close contacts, ideally with rapid diagnostic tests, should be considered.

While a measure of last resort, school closures can contribute to a reduction in SARS-CoV-2 transmission, but are by themselves insufficient to prevent community transmission of COVID-19 in the absence of other nonpharmaceutical interventions and the expansion of vaccination coverage. The effectiveness of school closures appears to have declined in the second wave as compared to the first wave of the COVID-19 pandemic, possibly in part due to better hygiene measures in school settings.

See Section: AGE TRENDS IN NOTIFICATIONS OF COVID-19

Pooled data from over 16 million case-based records from 16 countries up to 20 June 2021 show that in the most recent peak of COVID-19 that started in March 2021, case notification rates in adolescents aged 16-18 years increased the most sharply, and have since remained the highest rate seen among all age-groups. The trend for this age-group is mirrored most closely by rates in adolescents aged 12-15 years. Increased incidence was less steep and/or started later among other paediatric age-groups, with decreasing age leading to shallower gradients and lower peak rates.

Level 1

National Institute for Public Health and the Environment (Netherlands) (2021) Children, school and COVID-19, National institute for public health and the environment[3]

Worldwide, relatively few children have been reported with COVID-19. Children become less seriously ill and almost never need to be hospitalised because of infection with SARS-CoV-2.

Contagiousness increases with age.

In general, the younger the child, the less significant the role spreading the virus. This applies to the original virus variant and to the more contagious virus variants that have been circulating in the Netherlands since the end of last year. However, the more contagious variants involve more transmission of the virus in all age-groups.

When the number of SARS-CoV-2 infections in the Netherlands increases or decreases, infections increase or decrease in all age-groups, including children.

[3] National Institute for Public Health and the Environment (2021) Children, school and COVID-19, National institute for public health and the environment. https://www.rivm.nl/en/coronavirus-covid-19/children-and-covid-19.

Level 1

American Academy of Pediatrics (2021) COVID-19 Interim Guidance: Return to Sports and Physical Activity[4]

This guidance applies to children and adolescents who are participating in and/or returning to physical activity, inclusive of but not limited to organized sports and physical education classes within schools. Paediatricians should consider any children or adolescents who participate in any physical activity — organized or not — to fall within the context of the guidance.

This update provides an overview of ongoing repercussions from lack of athletic/physical fitness opportunities for youth; stresses the importance of high-yield risk mitigation strategies; clarifies recommendations for face mask use in sports; modifies post-illness medical clearance; and encourages people to receive a COVID-19 vaccine as soon as eligible.

Approximately 35 to 45 million [children and adolescents] 6 to 18 years of age participate in some form of athletics. The COVID-19 pandemic has affected many aspects of the lives of children and families, including youth sport activity. As children present for health supervision visits and pre-participation physical evaluations, parents and athletes will ask questions about how best to ensure safety when considering a return to sports participation and physical activity. This guidance is intended for paediatricians to inform families on how to mitigate risk and prevent the spread of SARS-CoV-2 to others within sports and other physical activities.

[4] American Academy of Pediatrics (2021) COVID-19 Interim Guidance: Return to Sports and Physical Activity https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/covid-19-interim-guidance-return-to-sports/.

Level 1

American Academy of Pediatrics (2021) COVID-19 Guidance for Safe Schools[5]

The purpose of this guidance is to continue to support communities, local leadership in education and public health and paediatricians collaborating with schools in creating policies for safe schools during the COVID-19 pandemic based on available evidence. As the next school year begins, there needs to be a continued focus on keeping students safe, since not all students will have the opportunity or be eligible to be vaccinated before the start of the next school year. Since the beginning of the pandemic, new information has emerged to guide safe in-person learning. Remote learning highlighted inequities in education, was detrimental to the educational attainment of students of all ages, and exacerbated the mental health crisis among children and adolescents. Opening schools generally does not significantly increase community transmission, particularly when guidance outlined by the World Health Organization (WHO), United Nations Children's Fund (UNICEF) and Centers for Disease Control and Prevention (CDC) is followed. There are still possibilities for transmission of SARS-CoV-2, especially for individuals and families who have chosen not to be vaccinated or are not eligible to be vaccinated. In addition, SARS-CoV-2 variants have emerged that may increase the risk of transmission and result in worsening illness.

However, the American Academy of Pediatrics (AAP) asserts that, at this point in the pandemic, given what we know about low rates of in-school transmission when proper prevention measures are used — together with the availability of effective vaccines for those aged 12 years or more — that the benefits of in-person school outweigh the risks in almost all circumstances. Along with our colleagues in the field of education, the AAP strongly advocates for additional federal assistance to all schools throughout the United States, irrespective of

[5] American Academy of Pediatrics (2021) COVID-19 Guidance for Safe Schools. https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/covid-19-planning-considerations-return-to-in-person-education-in-schools/.

whether the current local context allows for in-person instruction.

Level 1

Folkhälsomyndigheten [Public Health Agency] (Sweden) (2020) COVID-19 in children and adolescents[6]

NUMBER OF CASES AMONG CHILDREN AND ADOLESCENTS INCREASES WITH AGE

A very small proportion of cases have been diagnosed among children up to 6 years of age both in Sweden and globally, but it should be borne in mind that young children have also not been extensively tested. However, slightly more cases are seen as the children get older. With increasing age, a rising number of cases is seen among teenagers, but not as many as among people over 19 years of age.

Teenagers seem to be more susceptible to becoming infected than younger children, but experience mild symptoms. Teenagers also transmit the infection to a greater extent than younger children, but to a lesser extent than adults. During October, the number of diagnosed cases increased, especially among older teenagers. A contributing reason for greater transmission among teenagers may be that they move around more in society and often have many close contacts. The specific role of teenagers in the spread of infection needs to be investigated further through outbreak investigations and infection tracking.

THE INFECTION SEEMS TO SPREAD MORE DURING LEISURE TIME THAN AT SCHOOL

No studies have indicated widespread contagion in schools or between children. Since the start of the autumn term, some outbreaks have been reported in schools, mainly in relation to adults and older children or teenagers.

[6] Folkhälsomyndigheten [Public Health Agency] (Sweden) COVID-19 in children and adolescents. https://www.folkhalsomyndigheten.se/contentassets/1e5e09395b9a4f498ff635cdd2b1a888/covid-19-children-adolescents.pdf. Accessed 20 July 2021.

In some cases, it is difficult to determine whether the infection spread during leisure time or at school. The knowledge we have today indicates that schools as such do not seem to be a risk environment for children. Rather, the infection seems to spread during leisure time, in close-contact sports and in other social contexts. A number of measures have been taken at schools such as adjusting schedules to avoid congestion, not allowing parents to stay on the premises, holding some of the teaching outdoors and allowing teaching of secondary school students to take place partly remotely. Professionals who meet larger groups of children in schools, primary school teachers, preschool teachers and child minders do not have a higher relative risk of being diagnosed with COVID-19 compared to other professions.

CHILDREN ARE NOT THE DRIVING FORCE OF THE PANDEMIC

The scientific knowledge gained since June about children and adolescents and COVID-19 largely confirms previous knowledge. Children generally experience milder symptoms than adults, and a large proportion show mild or no symptoms. Fever and a cough are the most commonly reported symptoms. Children are not driving the COVID-19 pandemic. Children are rarely index cases, and scientific studies show that infectivity between children is significantly lower than between adults. No clear risk groups have so far been identified in children, but the Swedish Public Health Agency is continuously monitoring the state of knowledge. Few children have needed intensive care and even fewer have died, both in Sweden and internationally.

SCHOOL CLOSURES MIGHT HAVE NEGATIVE EFFECTS

Knowledge of the consequences of school closures has increased. Potential negative effects such as loss of learning and impact on mental and physical health have been highlighted. The negative consequences might have hit hardest against children who are already at risk such as children with disabilities, children with underlying

diseases, children in socio-economically disadvantaged groups and children living in social vulnerability and poverty. In the light of current knowledge and in a situation where the pandemic is far from over, it is important to take measures that allow children and adolescents to attend preschool, primary and secondary schools as far as possible.

Evidence Synopsis Resources

Level 2

[BMJ Best Practice (2021) Coronavirus disease 2019 (COVID-19)[7]]

See Section: ADOLESCENTS

Adolescents appear to have similar susceptibility to infection as adults.

In the US, hospitalisations in adolescents peaked at 2.1 per 100,000 in early January 2021, declined to 0.6 per 100,000 in March, and rose to 1.3 per 100,000 in April. Among hospitalised adolescents, approximately one third required admission to the Intensive Care Unit and 5% required mechanical ventilation. This data was based on 204 adolescents who were likely hospitalised primarily for COVID-19 during January 1 to March 31 2021.The cumulative number of hospitalisations in the 5 to 17 year old age bracket from March 2020 to June 2021 was 1909 cases.

[7] BMJ Best Practice (2021) Coronavirus disease 2019 (COVID-19). https://bestpractice.bmj.com/topics/en-gb/3000201/prevention. Accessed 15 July 2021.

See Section: CHILDREN

Evidence suggests that children have a lower susceptibility to infection compared with adults, with an odds ratio of 0.56 for being an infected contact compared with adults. Most cases in children are from familial clusters, or children who have a history of close contact with an infected patient. It is rare for children to be the index case in household transmission clusters. Infection rates vary according to geographical location. The mean age of children with infection was 6.5 years in the first wave. Different to adults, children do not seem to be at higher risk for severe illness based on age or sex.

In Britain, a prospective observational cohort study found that children and young adults represented 0.9% of all hospitalised patients at the time. The median age of children admitted to hospital was 4.6 years, 56% were male, 35% were under 12 months of age, and 42% had at least one comorbidity. In terms of ethnicity, 57% were White, 12% were South Asian, and 10% were Black. Age under 1 month, age 10 to 14 years, and Black race were risk factors for admission to critical care.

In the United States, a retrospective cohort study of over 135,000 children found that the mean age of infected children was 8.8 years, and 53% were male. In terms of ethnicity, 59% were White, 15% were Black, 11% were Hispanic, and 3% were Asian. Only 4% of children tested positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in this population, and clinical manifestations were typically mild. Cases in children, adolescents and young adults increased between October to December 2020; however, hospitalizations, Intensive Care Unit admissions and deaths remain low for these groups (2.5%, 0.8%, and <0.1% respectively, based on available data).

Globally, the case fatality rate in children appears to be higher in low- and middle-income countries compared with high-income countries.

See Section: ASYMPTOMATIC TRANSMISSION

Children are more likely to be asymptomatic. The pooled proportion of asymptomatic cases in children was thought to be significant; however, recent studies have found that the rate of asymptomatic infection in children was very low (1% compared with 9% in adults in one study, and 0.6% compared with 1.8% in adults in another study), indicating that children appear not to be particular drivers of the pandemic.

See Section: SUPERSPREADING EVENTS

Superspreading events have been reported. These events are associated with explosive growth early in an outbreak and sustained transmission in later stages.

Reported events include church/religious gatherings, family or social gatherings, weddings, choir practices, overnight youth camps or high school retreats, fitness classes, indoor recreational sporting activities, business conferences, and working in call centres. Widespread transmission has also been reported in long-term care facilities, homeless shelters, prisons, immigration detention centres, and meat and poultry processing facilities, as well as on board cruise ships.

Limited transmission has been reported in childcare, school and university settings, and infected cases may transmit the infection to their household members. There is limited high-quality evidence to quantify the extent of transmission in schools, or to compare it with community transmission. However, emerging evidence suggests a lower overall infection attack rate in students (0.15%) compared with school staff (0.7%).

Some individuals are supershedders of virus, but the reasons underlying superspreader events are often more complex than just excess virus shedding and can include a variety of behavioural, host and environmental factors.

See Section: SECONDARY ATTACK RATE

The secondary attack rate is the proportion of people exposed to an index (or primary) case that go on to develop the disease as a result of the exposure.

The pooled secondary attack rate among all close contacts of an index case has been estimated to be 7%.

The secondary attack rate differs between contact settings. More familiar prolonged contact increases the potential for transmission. Pooled estimates of the secondary attack rate range from 1.2% to 5.9% in social settings (depending on level of contact and whether contact is with strangers or family and friends), 1.9% in workplaces (based on limited data), 3.6% in healthcare facilities, and 21.1% for household settings (increases with exposure >5 days).

Another systematic review and meta-analysis of household transmission estimates the pooled household secondary attack rate to be slightly lower at 16.6%. The rate is higher for symptomatic index cases (18%) compared with asymptomatic cases (0.7%), and adults have a higher susceptibility to infection compared with children. Spouses of the index case are more likely to be infected compared with other household members.

The secondary attack rate increases with the severity of the index case (0.3% for asymptomatic cases to 6.2% for severe/critical cases) according to a study of 3410 close contacts of 391 index cases.

The secondary attack rate for close contacts of presymptomatic people has been estimated to be approximately 7%, compared with 1% in asymptomatic people and 6% in symptomatic people.

Children aged <5 years had lower secondary attack rates compared with older children, and the risk of infection was higher if the household index case was the mother. The secondary attack rate was 1.2% in children in a childcare setting or school.

Secondary attack rates for SARS-CoV-2 variants may differ.

Level 2

UpToDate (2021) COVID-19: Clinical manifestations and diagnosis in children[8]

Children of all ages can get COVID-19. Children, particularly those younger than 12 to 14 years of age, appear to be affected less commonly than adults, although children typically have a lower risk of exposure than adults and are tested less frequently than adults. In studies where children and adolescents were tested for acute or past severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection without respect to symptoms, the rates of infection in children ≥5 years were similar to or greater than those in adults. In surveillance from various countries children typically account for up to 15% of laboratory-confirmed cases.

In the United States, children <18 years account for approximately 12%-14% of laboratory-confirmed cases reported to the Centers for Disease Control and Prevention (CDC). The weekly number of cases reported to the CDC among persons <21 years of age has increased over time, possibly because increased numbers of children were tested as testing availability increased. Children account for approximately 20% of newly identified cases each week. The American Academy of Pediatrics provides information about the number of cases in children in individual states. Additional information related to COVID-19 activity in the United States is available through the CDC's *COVID View*.

The number of laboratory-confirmed cases of SARS-CoV-2 infection in children reported to the CDC is likely underestimated given the high proportion of mild and asymptomatic cases in which testing may not be performed. Based on serology from a convenience sample of routine laboratory specimens, approximately 114,000 children from a single state were estimated to have been infected by mid-September 2020 compared with approximately 9000 cases reported to the state health department by the end of August.

[8] UpToDate (2021) COVID-19: Clinical manifestations and diagnosis in children. https://www.uptodate.com/contents/covid-19-clinical-manifestations-and-diagnosis-in-children.

AGE DISTRIBUTION

Children of all ages can get COVID-19. The incidence increases with increasing age.

HOW DO CHILDREN GET COVID-19?

In case series early in the pandemic, most cases in children resulted from household exposure, usually with an adult as the index patient. These findings must be interpreted with caution because the cases were identified after implementation of strict physical distancing measures, limiting the exposure of children to close contacts outside their household.

In observational studies of household transmission, the secondary attack rate among paediatric contacts (<18 years of age) has ranged from 4% to 57%. In a meta-analysis of 54 studies of household transmission including 77,758 participants from multiple countries, the secondary attack rate was 17% among paediatric contacts (age <18 years) and 28% among adult contacts.

In a case-control study, close contact with persons with COVID-19 (typically a household member), having visitors to the home, and attending gatherings with persons outside the household such as social functions or activities with other children were associated with SARS-CoV-2 infection in children and adolescents.

Healthcare-associated outbreaks and cases of possible transmission from teachers or school staff to students and among students in the school setting have also been reported. In a case-control study, inconsistent mask use at school was associated with SARS-CoV-2 infection, whereas school-attendance itself was not.

DO CHILDREN TRANSMIT SARS-COV-2 TO OTHERS?

Children of all ages can transmit SARS-CoV-2 to others, but the rate of transmission by young children is uncertain. Older children and adolescents transmit SARS-CoV-2 effectively in household and

community settings. Infected children shed SARS-CoV-2 virus with nasopharyngeal viral loads comparable to or higher than those in adults. Viral loads and the risk of transmission appear to be greater in symptomatic than in asymptomatic individuals.

HOUSEHOLD TRANSMISSION

Limited evidence suggests that transmission from children to household contacts occurs, although the relative frequency of transmission from young children compared with other age-groups is uncertain.

Household contact studies have identified variable rates of transmission from paediatric index cases. In some studies, transmission from children to household contacts is infrequent; in other studies, rates of transmission from children to household contacts are similar to or higher than those in adults. The variable rates may be related to different community prevalence and mitigation measures, methods of diagnosing secondary cases, timing of sample collection, and levels of adherence to infection control measures in the home.

TRANSMISSION IN EDUCATIONAL OR CHILD CARE SETTINGS

Limited evidence suggests that transmission by pre-adolescent children occurs but is uncommon in educational or child care settings, particularly if the class size is small, other public health measures are strictly followed, and community transmission is low, although these findings are inconsistent. Several studies have documented transmission by adolescents in high school or secondary school, but these findings are also inconsistent.

Transmission by presymptomatic children and adolescents also appears to be uncommon in educational settings when effective case-contact testing and epidemic control strategies such as universal use of well-fitted masks, physical distancing or improved ventilation are implemented. In a prospective cohort from Australia, where most schools remained open during the first wave of the pandemic, among

752 contacts (649 children and 103 adults) of 12 children who attended primary school, secondary school or early childhood education and care while infectious with COVID-19, only 3 secondary infections were identified.

In the United States and other countries, resumption of in-person primary and secondary education before the emergence of more transmissible variants was associated with relatively few reports of school outbreaks when mitigation strategies such as mask-wearing or cohorting classrooms were in place. In a study of elementary school-associated transmission, inadequate mask use by students and less-than-ideal physical distancing were involved in all nine clusters in a single school district. Two clusters that accounted for 15 of 31 school-associated cases involved probable transmission between teachers followed by transmission from teachers to students. In addition, in surveillance in the United States between March and December 2020, the aggregate incidence of SARS-CoV-2 in counties offering in-person kindergarten through twelfth grade education was similar to that in counties offering online-only kindergarten through twelfth grade education.

TRANSMISSION BY ASYMPTOMATIC CHILDREN

Although there is little information about transmission of SARS-CoV-2 by truly asymptomatic (as opposed to presymptomatic) children, transmission from children with confirmed asymptomatic SARS-CoV-2 to household contacts has been reported. In addition, there are reports of familial clusters that included asymptomatic children and possible transmission from asymptomatic children to adults outside their family.

These reports suggest that asymptomatic children may play a role in transmission. Asymptomatic transmission by adults is well documented.

HOW OFTEN ARE CHILDREN WITH COVID-19 HOSPITALIZED?

In CDC population-based surveillance, weekly hospitalization rates among children <18 years in the United States peaked in January 2021 (1.4 per 100,000 population), decreased through mid-March, and then began to increase, particularly among adolescents age 12 to 17 years and children younger than 4 years. Hospitalization rates vary widely from state to state.

With universal testing for SARS-CoV-2 upon admission at most hospitals, the rates of hospitalization for SARS-CoV-2 in children may be overestimated if hospitalizations for SARS-CoV-2-related illness are not differentiated from hospitalizations for other reasons (eg elective surgery, trauma) with incidental detection of SARS-CoV-2. In two single-center studies of paediatric hospitalizations during which SARS-CoV-2 was detected, SARS-CoV-2 positivity was considered incidental in 4%0 to 45%.

Despite the trend of increasing hospitalization, a minority of children with COVID-19 require hospitalization. Among >69,700 laboratory-confirmed cases of COVID-19 in children reported to the CDC by May 30, 2020, the hospitalization rate ranged from 2.5% to 4.1%. Among children and adolescents hospitalized with COVID-19, approximately one-third required intensive care, and 5% required invasive mechanical ventilation.

In CDC surveillance of COVID-19 in the United States, underlying conditions are associated with higher rates of hospitalization (15% to 22% *vs.* 2% to 4%) and intensive care unit (ICU) admission (4% to 5% *vs.* <1%). Whether underlying conditions are associated with increased severity or a lower threshold for admission because of concern for complications is unclear. Age <1 year has also been associated with increased rates of hospitalization, although hospitalization of infants may not reflect severity of illness.

Additional information regarding hospitalization of children in the United States is available through the CDC's *COVIDView*.

Why COVID-19 appears to be less common and less severe in children than in adults is unclear. One possibility is that children have a less

intense immune response to the virus than adults; cytokine release syndrome is thought to be important in the pathogenesis of severe COVID-19 infections. Other possibilities include viral interference in the respiratory tract of young children, which may lead to a lower SARS-CoV-2 viral load; different expression of the angiotensin converting enzyme 2 receptor (the receptor for SARS-CoV-2) in the respiratory tracts of children and adults; pre-existing cross-reactive antibody; a vigorous early mucosal immune response, protective off-target effects of live vaccines; and relatively healthier blood vessels in children than in adults. In addition, the possibility of decreased exposure and decreased rates of testing in children may play a role.

Level 2

UpToDate (2021) COVID-19: Epidemiology, virology, and prevention[9]

The risk of transmission after contact with an individual with COVID-19 increases with the closeness and duration of contact and appears highest with prolonged contact in indoor settings. Thus, most secondary infections have been described among household contacts. One systematic review of 54 studies evaluated secondary infection rates among household or family contacts of index patients with COVID-19. Among 77,758 contacts in Asia, Europe, the United States, and Australia, the estimated pooled household secondary infection rate was 17%, with substantial variability across studies (range 4% to 45%). Within households, spouses or significant others have the highest secondary infection rates. Nevertheless, children and adolescents can also serve as index cases for secondary household infections.

[9] UpToDate (2021) COVID-19: Epidemiology, virology, and prevention. https://www.uptodate.com/contents/covid-19-epidemiology-virology-and-prevention.

Level 2

UpToDate (2021) COVID-19: Management in children[10]

See Section: PHYSICAL DISTANCING AND SARS-COV-2 TRANSMISSION IN SCHOOLS

In observational studies from several regions of the United States, transmission of SARS-CoV-2 in schools is low when physical distancing of ≥3 feet is combined with other mitigation measures and case rates are similar whether schools use ≥3 or ≥6 feet. Based on these studies, the US Centers for Disease Control and Prevention now recommends ≥3 or ≥6 feet depending on circumstances; ≥6 feet is recommended when masks cannot be worn, between adults, between adults and students, and for middle and high school students in areas with high community transmission if cohorting is not possible. Continued vigilance is necessary because the studies preceded the emergence of variants associated with increased transmission.

See Section: IN-PERSON SCHOOL AND CHILD CARE

Observational studies suggest that severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission rates in schools are low with physical distancing of approximately ≥3 feet (0.9 meters), provided that other mitigation measures are in place. Although retrospective case rates among students and staff were similar whether eligible school districts in Massachusetts planned to implement a minimum physical distance of ≥3 feet or ≥6 feet, these findings must be interpreted with caution. Other factors — transmission in the community, mask-wearing, ventilation, ability to cohort students, exposure time — may play a larger role in transmission than physical distance. In addition, the study preceded the emergence of variants of concern.

[10] UpToDate (2021) COVID-19: Management in children.

SPORTS AND EXTRACURRICULAR ACTIVITIES

Centers for Disease Control and Prevention (CDC) guidance permits fully vaccinated children and adolescents to participate in sports and extracurricular activities without wearing masks or physical distancing except where these measures are required by local regulations. Decisions about participation in sports and extracurricular activities for unvaccinated children should be made on a case-by-case basis. Factors to consider include the ability to maintain mitigation measures such as physical distance, mask wearing, and ventilation; and whether activities increase the risk of transmission among students or staff: eg resulting in or requiring deep breathing such as intense exercise, shouting, or singing.

Indoor sports, close contact team sports and intense exercise have been associated with increased transmission. Social gatherings associated with team sports may also increase the risk of transmission. The CDC provides additional guidance for sports participation in unvaccinated people.

Irish and/or International Literature

Level 1

Ludvigsson (2020) [Systematic Review] Children are unlikely to be the main drivers of the COVID-19 pandemic - A systematic review[11]

METHODS: A systematic literature review of Medline and Embase and the medRxiv/bioRxiv preprint servers to 11 May 2020 to identify published and unpublished studies on COVID-19 transmission by children.

RESULTS: 47 articles were studied in detail. Children accounted for a small fraction of COVID-19 cases and mostly had social contacts with peers or parents, rather than older people at risk of severe disease. Data on viral loads were scarce, but indicated that children may have lower levels than adults, partly because they often have fewer symptoms. Lower viral loads in children should decrease the risk of transmission. Household transmission studies showed that children were rarely the index case and case studies suggested that children with COVID-19 seldom caused outbreaks. However, it is highly likely that children can transmit the SARS-COV-2 virus, and even asymptomatic children can have viral loads.

Level 1

Xu et al (2020) [Systematic Review] What is the evidence for transmission of COVID-19 by children in schools? A living systematic review[12]

BACKGROUND: It is of paramount importance to understand the transmission of SARS-CoV-2 in schools, which could support the decision-making about educational facilities closure or re-opening

[11] Ludvigsson JF. Children are unlikely to be the main drivers of the COVID-19 pandemic - A systematic review. Acta Paediatr. 2020 Aug;109(8):1525-1530. doi: 10.1111/apa.15371. Epub 2020 Jun 17. PMID: 32430964; PMCID: PMC7280674.

[12] Xu W, Li X, Dozier M, He Y, Kirolos A, Lang Z, Mathews C, Siegfried N, Theodoratou E; UNCOVER. What is the evidence for transmission of COVID-19 by children in schools? A living systematic review. J Glob Health. 2020 Dec;10(2):021104. doi: 10.7189/jogh.10.021104. PMID: 33437465; PMCID: PMC7774027.

with effective prevention and control measures in place.

METHODS: The authors conducted a systematic review and meta-analysis to investigate the extent of SARS-CoV-2 transmission in schools. A risk of bias evaluation of all included studies was performed using the Newcastle-Ottawa Scale (NOS).

RESULTS: 2178 articles were retrieved and 11 studies included. 5 cohort studies reported a combined 22 student and 21 staff index cases that exposed 3345 contacts with 18 transmissions (overall infection attack rate (IAR): 0.08%, 95% confidence interval (CI) = 0.00%-0.86%). IARs for students and school staff were 0.15% (95% CI = 0.00%-0.93%) and 0.70% (95% CI = 0.00%-3.56%), respectively. 6 cross-sectional studies reported 639 SARS-CoV-2 positive cases in 6682 study participants tested. The SARS-CoV-2 positivity rate was estimated to be 8.74% (95% CI = 2.34%-18.53%) among students, compared to 13.68% (95% CI = 1.68%-33.89%) among school staff. Gender differences were not found for secondary infection (OR = 1.44, 95% CI = 0.50-4.14, p = 0.49) and SARS-CoV-2 positivity (OR = 0.90, 95% CI = 0.72-1.13, p = 0.36) in schools. Fever, cough, dyspnea, ageusia, anosmia, rhinitis, sore throat, headache, myalgia, asthenia and diarrhoea were all associated with the detection of SARS-CoV-2 antibodies. Overall, study quality was judged to be poor with risk of performance and attrition bias, limiting confidence in the results.

CONCLUSIONS: There is limited high-quality evidence available to quantify the extent of SARS-CoV-2 transmission in schools or to compare it to community transmission. Emerging evidence suggests lower IAR and SARS-CoV-2 positivity rate in students compared to school staff. Future prospective and adequately controlled cohort studies are necessary to confirm findings.

Level 1

Viner et al (2021) [Systematic Review and Meta-Analysis] Susceptibility to SARS-CoV-2 Infection Among Children and Adolescents Compared With Adults: A Systematic Review and Meta-Analysis[13]

IMPORTANCE: The degree to which children and adolescents are infected by and transmit severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is unclear. The role of children and adolescents in transmission of SARS-CoV-2 is dependent on susceptibility, symptoms, viral load, social contact patterns, and behavior.

OBJECTIVE: To systematically review the susceptibility to and transmission of SARS-CoV-2 among children and adolescents compared with adults.

DATA SOURCES: PubMed and medRxiv were searched from database inception to July 28, 2020, and a total of 13,926 studies were identified, with additional studies identified through hand searching of cited references and professional contacts.

STUDY SELECTION: Studies that provided data on the prevalence of SARS-CoV-2 in children and adolescents compared with adults (≥20 years) derived from contact tracing or population screening were included. Single-household studies were excluded.

DATA EXTRACTION AND SYNTHESIS: PRISMA guidelines for abstracting data were followed, which was performed independently by 2 reviewers. Quality was assessed using a critical appraisal checklist for prevalence studies. Random-effects meta-analysis was undertaken.

MAIN OUTCOMES AND MEASURES: Secondary infection rate in

[13] Viner RM, Mytton OT, Bonell C, Melendez-Torres GJ, Ward J, Hudson L, Waddington C, Thomas J, Russell S, van der Klis F, Koirala A, Ladhani S, Panovska-Griffiths J, Davies NG, Booy R, Eggo RM. Susceptibility to SARS-CoV-2 Infection Among Children and Adolescents Compared With Adults: A Systematic Review and Meta-analysis. JAMA Paediatr. 2021 Feb 1;175(2):143-156. doi: 10.1001/jamapaediatrics.2020.4573. Erratum in: JAMA Paediatr. 2021 Feb 1;175(2):212. PMID: 32975552; PMCID: PMC7519436.

contact-tracing studies or prevalence or seroprevalence in population screening studies among children and adolescents compared with adults.

RESULTS: A total of 32 studies comprising 41,640 children and adolescents and 268,945 adults met inclusion criteria, including 18 contact-tracing studies and 14 population screening studies. The pooled odds ratio of being an infected contact in children compared with adults was 0.56 (95% CI, 0.37-0.85), with substantial heterogeneity (I2 = 94.6%). Three school-based contact-tracing studies found minimal transmission from child or teacher index cases. Findings from population screening studies were heterogenous and were not suitable for meta-analysis. Most studies were consistent with lower seroprevalence in children compared with adults, although seroprevalence in adolescents appeared similar to adults.

CONCLUSIONS AND RELEVANCE: In this meta-analysis, there is preliminary evidence that children and adolescents have lower susceptibility to SARS-CoV-2, with an odds ratio of 0.56 for being an infected contact compared with adults. There is weak evidence that children and adolescents play a lesser role than adults in transmission of SARS-CoV-2 at a population level. This study provides no information on the infectivity of children.

Level 1

Spielberger et al (2021) [Systematic Review] Intra-Household and Close-Contact SARS-CoV-2 Transmission Among Children - a Systematic Review[14]

INTRODUCTION: Early in the pandemic, children were suspected to act as drivers of the COVID-19 spread in the population, which was based on experiences with influenza virus and other respiratory pathogens. Consequently, closures of schools and kindergartens were implemented in many countries around the world, alongside other

[14] Spielberger BD, Goerne T, Geweniger A, Henneke P, Elling R. Intra-Household and Close-Contact SARS-CoV-2 Transmission Among Children - a Systematic Review. Front Paediatr. 2021 Apr 9;9:613292. doi: 10.3389/fped.2021.613292. PMID: 33898355; PMCID: PMC8062727.

non-pharmaceutical interventions for transmission control. Given the grave and multifaceted consequences of contact restriction measures for children, it is crucial to better understand the effect size of these incisive actions for the COVID-19 pandemic. The authors systematically reviewed the current evidence on SARS-CoV-2 transmission to and by children.

DATA SOURCES: PubMed and preprints uploaded on medRxiv.

STUDY SELECTION: Original research articles, case reports, brief communications and commentaries were included into the analysis. Each title or abstract was independently reviewed to identify relevant articles. Studies in other languages than English were not included.

DATA EXTRACTION: Two reviewers independently reviewed the selected studies. Extracted data included citation of each study, type of healthcare setting, location of the study, characteristics of patient population, and reported outcomes.

RESULTS: Data on transmission of SARS-CoV-2 on or by children is scarce. Several studies show a lower seropositivity of children compared to adults, suggesting a lower susceptibility of especially younger children. Most insight currently comes from household studies which indicate that children are predominantly infected by their household contacts. The contagiousness however, seems to be comparable between children and adults. After conducting the meta-analysis, the authors reported a pooled secondary attack rate for a child index of 13.40% (95%CI 5.7–21.1) compared to 12.32% (95%CI 8.3–16.4) for an adult index. Significant heterogeneity among included studies was reported.

CONCLUSIONS: Larger and systematic studies are urgently needed to better understand the age dependent patterns of SARS-CoV-2 transmission and thereby design more effective non-pharmaceutical interventions to reduce disease transmission.

Level 1

Li et al (2020) [Systematic Review and Meta-Analysis] Epidemiological and Clinical Characteristics of COVID-19 in Children: A Systematic Review and Meta-Analysis[15]

This systematic review with meta-analysis aimed to evaluate the epidemiological spectrum and clinical characteristics of children infected with SARS-CoV-2. Relevant international and Chinese public databases were systematically searched to identify all case studies from January 1, 2020 to May 7, 2020. 96 studies involving 7004 cases were included. The mean age of paediatric cases was 6.48 years (95% CI 52.0-77.5), 90% had at least one household contact, and 66% presented with mild to moderate clinical syndromes. The main symptoms were fever (47%, 95% CI 41%-53%) and cough (42%, 95% CI 36%-48%). About 23% of children were asymptomatic, 27% had comorbidity, and 29% had a co-infection. The pooled mean incubation period was 9.57 days (95% CI 7.70-11.44). The shedding of SARS-CoV-2 in the upper respiratory tract lasted 11.43 days, and 75% of patients had virus particles in their stool. A total of 34% of the children had neutropenia and 26% had lymphocytosis. Interferon-alpha (81%) was the most commonly used antiviral drug in the children. The discharge and death rates were 79 and 1%. In conclusion, the transmissibility of paediatric COVID-19 should not be ignored because of the relatively long incubation period, shedding duration, and mild clinical symptoms.

[15] Li B, Zhang S, Zhang R, Chen X, Wang Y, Zhu C. Epidemiological and Clinical Characteristics of COVID-19 in Children: A Systematic Review and Meta-Analysis. Front Paediatr. 2020 Nov 2;8:591132. doi: 10.3389/fped.2020.591132. PMID: 33224909; PMCID: PMC7667131.

Level 1

Madewell et al (2020) [Systematic Review and Meta-Analysis] Household Transmission of SARS-CoV-2: A Systematic Review and Meta-analysis[16]

IMPORTANCE: Crowded indoor environments such as households are high-risk settings for the transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

OBJECTIVES: To examine evidence for household transmission of SARS-CoV-2, disaggregated by several covariates, and to compare it with other coronaviruses.

DATA SOURCE: PubMed, searched through October 19, 2020.

STUDY SELECTION: All articles with original data for estimating household secondary attack rate were included. Case reports focusing on individual households and studies of close contacts that did not report secondary attack rates for household members were excluded.

DATA EXTRACTION AND SYNTHESIS: Meta-analyses were done using a restricted maximum-likelihood estimator model to yield a point estimate and 95% CI for secondary attack rate for each subgroup analyzed, with a random effect for each study. To make comparisons across exposure types, study was treated as a random effect, and exposure type was a fixed moderator. The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guideline was followed.

MAIN OUTCOMES AND MEASURES: Secondary attack rate for SARS-CoV-2, disaggregated by covariates—*ie* household or family contact, index case symptom status, adult or child contacts, contact sex, relationship to index case, adult or child index cases, index case sex, number of contacts in household—and for other coronaviruses.

RESULTS: A total of 54 relevant studies with 77,758 participants

[16] Madewell ZJ, Yang Y, Longini IM Jr, Halloran ME, Dean NE. Household Transmission of SARS-CoV-2: A Systematic Review and Meta-analysis. JAMA Netw Open. 2020 Dec 1;3(12):e2031756. doi: 10.1001/jamanetworkopen.2020.31756. PMID: 33315116; PMCID: PMC7737089.

reporting household secondary transmission were identified. Estimated household secondary attack rate was 16.6% (95% CI, 14.0%-19.3%), higher than secondary attack rates for SARS-CoV (7.5%; 95% CI, 4.8%-10.7%) and MERS-CoV (4.7%; 95% CI, 0.9%-10.7%). Household secondary attack rates were increased from symptomatic index cases (18.0%; 95% CI, 14.2%-22.1%) than from asymptomatic index cases (0.7%; 95% CI, 0%-4.9%), to adult contacts (28.3%; 95% CI, 20.2%-37.1%) than to child contacts (16.8%; 95% CI, 12.3%-21.7%), to spouses (37.8%; 95% CI, 25.8%-50.5%) than to other family contacts (17.8%; 95% CI, 11.7%-24.8%), and in households with 1 contact (41.5%; 95% CI, 31.7%-51.7%) than in households with 3 or more contacts (22.8%; 95% CI, 13.6%-33.5%).

CONCLUSIONS AND RELEVANCE: The findings of this study suggest that given that individuals with suspected or confirmed infections are being referred to isolate at home, households will continue to be a significant venue for transmission of SARS-CoV-2.

Level 1

Irfan et al (2021) Risk of infection and transmission of SARS-CoV-2 among children and adolescents in households, communities and educational settings: A systematic review and meta-analysis[17]

There is uncertainty with respect to SARS-CoV-2 transmission in children (0-19 years) with controversy on effectiveness of school-closures in controlling the pandemic. It is of equal importance to evaluate the risk of transmission in children who are often asymptomatic or mildly symptomatic carriers that may incidentally transmit SARS-CoV-2 in different settings. The authors conducted a systematic review to assess transmission and risks for SARS-CoV-2 in children (by age-groups or grades) in community and educational-settings compared to adults.

METHODS: Data for the review were retrieved from PubMed,

[17] Irfan O, Li J, Tang K, Wang Z, Bhutta ZA. Risk of infection and transmission of SARS-CoV-2 among children and adolescents in households, communities and educational settings: A systematic review and meta-analysis. J Glob Health. 2021 Jul 17;11:05013. doi: 10.7189/jogh.11.05013. PMID: 34326997; PMCID: PMC8285769.

EMBASE, Cochrane Library, WHO COVID-19 Database, China National Knowledge Infrastructure (CNKI) Database, WanFang Database, Latin American and Caribbean Health Sciences Literature (LILACS), Google Scholar, and preprints from medRixv and bioRixv) covering a timeline from December 1, 2019 to April 1, 2021. Population-screening, contact-tracing and cohort studies reporting prevalence and transmission of SARS-CoV-2 in children were included. Data were extracted according to PRISMA guidelines. Meta-analyses were performed using Review Manager 5.3.

RESULTS: 90 studies were included. Compared to adults, children showed comparable national (risk ratio (RR) = 0.87, 95% confidence interval (CI) = 0.71-1.060) and subnational (RR = 0.81, 95% CI = 0.66-1.01) prevalence in population-screening studies, and lower odds of infection in community/household contact-tracing studies (odds ratio (OR) = 0.62, 95% CI = 0.46-0.84). On disaggregation, adolescents observed comparable risk (OR = 1.22, 95% CI = 0.74-2.04) with adults. In educational-settings, children attending daycare/preschools (OR = 0.53, 95% CI = 0.38-0.72) were observed to be at lower-risk when compared to adults, with odds of infection among primary (OR = 0.85, 95% CI = 0.55-1.31) and high-schoolers (OR = 1.30, 95% CI = 0.71-2.38) comparable to adults. Overall, children and adolescents had lower odds of infection in educational-settings compared to community and household clusters.

CONCLUSIONS: Children (<10 years) showed lower susceptibility to COVID-19 compared to adults, whereas adolescents in communities and high-schoolers had comparable risk. Risks of infection among children in educational-settings was lower than in communities. Evidence from school-based studies demonstrate it is largely safe for children (<10 years) to be at schools, however older children (10-19 years) might facilitate transmission. Despite this evidence, studies focusing on the effectiveness of mitigation measures in educational settings are urgently needed to support both public health and educational policy-making for school reopening.

Walsh et al (2021) Do school closures and school re-openings affect community transmission of COVID-19? A systematic review of observational studies[18]

OBJECTIVES: To systematically review the observational evidence of the effect of school closures and school re-openings on SARS-CoV-2 community transmission.

SETTINGS: Early childhood education, primary and secondary school settings.

INTERVENTION: School closures and re-openings.

OUTCOME MEASURE: Community transmission of SARS-CoV-2 including any measure of community infections rate, hospital admissions or mortality attributed to COVID-19.

METHODS: A systematic review of observational studies related to SARS-CoV-2 transmission in schools and community settings. The Cochrane Risk of Bias tool was used to evaluate bias.

RESULTS: The authors identified 7474 articles, of which 40 were included, with data from 150 countries. Of these, 32 studies assessed school closures and 11 examined re-openings. There was substantial heterogeneity between school closure studies, with half of the studies at lower risk of bias reporting reduced community transmission by up to 60%, and half reporting null findings. The majority (n=3 out of 4) of school re-opening studies at lower risk of bias reported no associated increases in transmission.

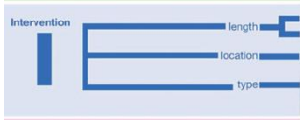
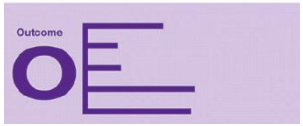
CONCLUSIONS: School closure studies were at risk of confounding and collinearity from other non-pharmacological interventions implemented around the same time, and the effectiveness of school closures remains uncertain. School re-openings in areas of low transmission and with appropriate mitigation measures were generally not accompanied by increasing community transmission.

[18] Walsh S, Chowdhury A, Braithwaite V, Russell S, Birch JM, Ward JL, Waddington C, Brayne C, Bonell C, Viner RM, Mytton OT. Do school closures and school reopenings affect community transmission of COVID-19? A systematic review of observational studies. BMJ Open. 2021 Aug 17;11(8):e053371. doi: 10.1136/bmjopen-2021-053371. PMID: 34404718; PMCID: PMC8375447.

Produced by the members of the National Health Library and Knowledge Service Evidence Team†. Current as at 20 July 2021. This evidence summary collates the best available evidence at the time of writing and does not replace clinical judgement or guidance. Emerging literature or subsequent developments in respect of COVID-19 may require amendment to the information or sources listed in the document. Although all reasonable care has been taken in the compilation of content, the National Health Library and Knowledge Service Evidence Team makes no representations or warranties expressed or implied as to the accuracy or suitability of the information or sources listed in the document. This evidence summary is the property of the National Health Library and Knowledge Service and subsequent re-use or distribution in whole or in part should include acknowledgement of the service.

This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.

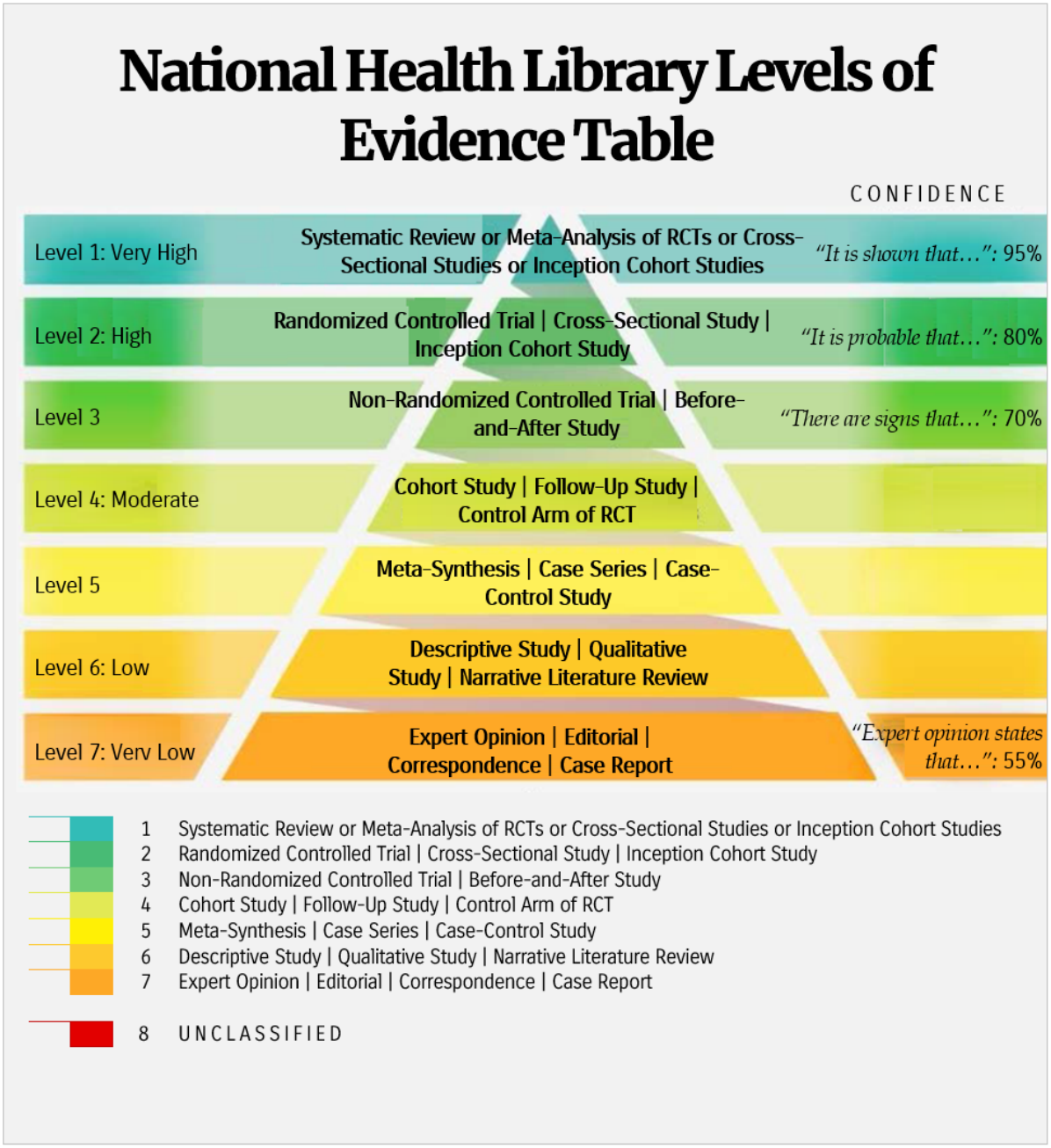
The following PICO(T) was used as a basis for the evidence summary:

	ADOLESCENTS ~12-16 YEARS
	INFECTION WITH SARS-CoV-2
	NO INFECTION WITH SARS-CoV-2
	HOSPITALIZATION; ICU ADMISSION; MOTRALITY; TRANSMISSION TO OTHERS

The following search strategy was used:

1 exp Coronavirinae/ (50999)
2 COVID-19.ab,ti. (115210)
3 coronavirus.ab,ti. (57105)
4 "corona virus".ab,ti. (2013)
5 (Wuhan adj3 virus).ab,ti. (113)
6 ("2019-nCoV" or "2019 ncov").ab,ti. (1263)
7 "severe acute respiratory syndrome coronavirus 2".ab,ti. (12277)
8 ("2019" and (new or novel) and coronavirus).ab,ti. (9717)
9 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 (147731)

The following schema was used to grade the levels of evidence included:



† Brendan Leen, Area Library Manager, HSE South [Author, Editor]; Gethin White, Librarian, Dr. Steevens' Hospital, Dublin [Author]; Siobhan McCarthy, Information Specialist, Health Intelligence Unit, Strategic Planning and Transformation [Author]; Shauna Barrett, Librarian, Cork University Hospital [Author]; NIAC Sub-Group Contributors: Dr. Peter O'Reilly; Dr. Philippa White; Dr. Geraldine Casey; Dr. Grace Kenny.