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Issue Note

Key considerations for introducing and lifting public health measures in kindergarten, elementary, secondary, and post-secondary schools

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Executive summary

The 2021-2022 academic year has already begun and there has been significant media coverage and discussion regarding how schools should operate. Vaccination rates and the emergence of novel and more contagious variants of concern, particularly the Delta variant, have shaped the evolution of the COVID-19 pandemic in Canada.

This Issue Note answers the following question: **For the 2021-2022 academic year, what are the key considerations to use in determining which public health measures are to be kept (e.g. masking) or introduced, (e.g. regular self-testing) in kindergarten, elementary, secondary, and post-secondary schools?**

The following are a set of key considerations, relevant for the 2021-2022 academic year and current pandemic situation in Canada, for determining appropriate public health measures for kindergarten, elementary, secondary, and post-secondary schools across Canada, based on recommendations from key guidance documents, briefings, and expert opinion.

First, based on accumulated scientific evidence throughout the pandemic, school closures should be an exceptional public health measure, invoked only in 'catastrophic' circumstances as it has wide-reaching impacts on student learning and development among kindergarten, elementary, and secondary school students as well as post-secondary students.

Second, there are three key metrics that should be considered when lifting or introducing public health measures in schools:

1. local vaccination rates in the community where the school is situated;
2. metrics for disease severity including deaths, hospitalizations, hospital bed occupancy, and intensive care unit capacities due to COVID-19; and
3. SARS-CoV-2 transmission in schools and the community where the school is situated.

Third, vaccines are the most effective public health measure to curb severe COVID-19 and priority should be placed on encouraging and promoting vaccination for all eligible individuals in schools. Vaccine delivery should reduce barriers to access vaccines (e.g. by creating vaccine centres or mobile units near schools).[1,2] Implementing mandatory vaccination policies among teachers, staff, and students who are eligible, may also be considered as an effective way to encourage vaccination and reduce SARS-CoV-2 transmission/serious outcomes of COVID-19, although emerging evidence is suggesting that while reduced, some transmission may still occur among the vaccinated.[3–5] Implementation and the frequency of rapid antigen testing (or self-testing) should be guided by the school community's prevalence of SARS-

CoV-2, outbreak status of the school, and the presence of variants of concern (e.g. the Delta variant). Rapid antigen testing can be effective when combined with and not prioritized over other essential public health measures including vaccination and case management. In outbreak settings, self-tests are effective tools for screening those who are asymptomatic and those who are unvaccinated[6] as they have a higher sensitivity in higher COVID-19 risk settings. While not as sensitive as a diagnostic test by PCR, a recent evidence synthesis of rapid or self-tests suggests they can successfully identify most COVID-19 infections in children with viral load levels likely to be infectious, notably in the first days of the illness. Serial rapid testing may help compensate for limited sensitivity in early infection. Test-to-play strategies may be considered for students involved in extracurricular close contact sports and athletics.[1]

Knowledge gaps and future research

We identified several knowledge gaps and recommendations for future research. Particularly:

a) Future research should assess the impact of variants of concern on SARS-CoV-2 transmission on post-secondary campuses, as well as their impact on the effectiveness of infection prevention and control strategies.[7]

b) As people become fully vaccinated, further research will be required to determine the thresholds and implications of any proposed reduction or relaxation of public health measures for particular populations or communities to minimize future spread.(3) However, as new variants emerge over the course of the pandemic, the need for continued public health measures in addition to vaccines is likely for the foreseeable future until a substantial proportion of the global population is fully vaccinated.

c) Future research should investigate the impacts of school closures on post-secondary students in terms of their careers and academic learning.

d) Future research should “invest in comprehensive population-based follow-up studies” to accurately understand the impact of school closures on children and youth.[8]

e) Future research should investigate the performance of rapid antigen tests in detecting infections with the Delta variant.

f) Finally, research should also investigate the impact of the rollout of rapid tests on the rest of the outbreaks and infections in elementary, secondary, and post-secondary schools testing.

Limitations

This Issue Note has several limitations:

- We did not formally assess the quality of the evidence or appraise the guidelines.
- Given the state of the evidence, some of the information and key considerations are matters of expert opinion and not evidence.
- Only English-language resources were consulted.
- Given the rapid timeframe for this report, some relevant information may have been missed.

Introduction

The 2021-2022 academic year has already begun. Students, teachers, and staff are attending kindergarten, elementary, secondary, and post-secondary schools across Canada for in-person learning.

There has been significant media coverage and discussion among experts and public health professionals regarding how schools should safely operate for in-person learning.

Since June 2021, two primary forces have shaped the evolution of the COVID-19 pandemic in Canada. The first is the vaccination rate. As of October 4, 2021, approximately 71% of the total Canadian population were fully vaccinated against COVID-19, and approximately 82% of eligible Canadians 12 years of age and older were fully vaccinated.[9] The school year began with a portion of vaccinated students, teachers, and education staff, and a portion who were eligible but unvaccinated, depending on local policies, such as for mandatory vaccination. Additionally, those born after 2009 (or under the age of 12 years) were considered ineligible to be vaccinated absent change to eligibility criteria.

The second force is the emergence of novel and more contagious variants of COVID-19. Four variants of concern (VOCs) have been the focus in most provinces and territories, including the B.1.1.7 (Alpha), B.1.351 (Beta), P.1. (Gamma), and the B.1.617.2 (Delta) variants.[10] As we approach Fall 2021, the highly infectious Delta variant is surging across Canada and abroad.[11]

Recently, many schools and other educational institutions have created policies and introduced new public health measures in order to open their doors safely. Among them include mandatory vaccination policies for education staff, the introduction of rapid testing for unvaccinated students and staff, and improvements to ventilation systems.

As the COVID-19 situation evolves, decision-makers will need to identify which public health measures should be imposed, when they should be imposed, and when they can be lifted in all schools including kindergarten, elementary, and secondary as well as post-secondary institutions (colleges and universities). This Issue Note aims to answer the following question:

> **For the 2021-2022 academic year, what are the key considerations to use in determining which public health measures are to be kept (e.g. masking) or introduced, (e.g. regular self-testing) in kindergarten, elementary, secondary, and post-secondary schools?**

Methods

Data for this report was retrieved through multiple academic and grey literature databases including LitCOVID, COVID-END, medRxiv, and custom Google searches. We also searched the website of the United States Centers for Disease Control and Prevention (CDC), and top academic journals including Nature and the Lancet. The selected databases focused on COVID-19-related research, published guidelines, evidence syntheses, and empirical research. We included texts published in English up until September 17, 2021, and that were related to the current COVID-19 situation in Canada. To supplement our database and website search, we gathered key papers that were relevant to our question through our expert consultations (please see Table 3 in the appendix for a list of experts we consulted).

We used various combinations of key terms including: “Delta”, “B.1.617.2”, “transmission”, “school*”, “vaccin*”, “hospital*”, “children”, “adolescents”, “post-secondary”, “universit*”, “college”. Articles were included if they focused on: SARS-CoV-2 transmission in schools (K-12) and post-secondary schools (colleges and universities); public health measures to mitigate the spread of SARS-CoV-2 for indoor learning; and the impact of the Delta variant and other VOCs on vaccine escape, transmission, and hospitalization.

Findings

The findings below provide a set of key considerations for determining appropriate public health measures for kindergarten, elementary, secondary, and post-secondary schools across Canada, based on recommendations from key guidance documents, briefings, scientific evidence, and expert opinion. Several professional, national, and provincial expert groups have provided guidance and data related to the impact of COVID-19 on children, including the British Columbia Centre for Disease Control, the Institut National de Santé Publique du Québec, the Royal Society of Canada, and the Ontario COVID-19 Science Advisory Table.[1,8,12,13] They focus on key public health metrics and measures that are relevant to the 2021-2022 academic year and the current pandemic situation in Canada. As the COVID-19 situation evolves, many of the key considerations outlined in this report may also evolve.

Differences and Similarities Between Kindergarten, Elementary Schools, Secondary, and Post-Secondary Institutions

COVID-19 infection rates

As of October 1, 2021, there have been 1,615,312 recorded cases of COVID-19 in Canada. These cases are not evenly spread across various age groups.[10] Specifically:

- 36% of cases were in individuals aged between 20 and 39 years of age. This is the age group that makes up the majority of university and college students [14]; and

- 20.2% of cases were in individuals under the age of 19 years, which is comprised of almost exclusively of kindergarten, elementary- and secondary-level students.[14]

During the first and second waves (i.e. between March 2020 and February 2021), a higher standardized infection rate ratio adjusting for test frequency, was seen in adolescents and males aged 20-49 years.[15] These groups account for much of the high school and post-secondary student population. The standard infection rate ratios were lowest in elementary school-aged children, as well as in adults aged 70 years and older.[15]

These rates may change as the COVID-19 pandemic situation evolves. This academic year began with a mix of vaccinated and unvaccinated students and staff, depending on eligibility and mandatory vaccination policies. Moreover, the increased spread of VOCs, including the more infectious Delta variant, may lead to an increase in transmission within schools and the community, particularly among the unvaccinated which includes children under 12, as shown in a case study in the US.[16] Finally, there is also a potential for reduced effectiveness of vaccines with the introduction of new variants and for waning immunity over time.[17] These scientific knowns and unknowns support the need for sustained preventive non-pharmaceutical public health measures in schools.[18]

School settings

Vaccination: When the 2021-2022 academic year began, approximately 73% of the total Canadian population, and approximately 84% of the total eligible Canadian population (those 12 years of age and over), had received at least one dose of an approved COVID-19 vaccine. About 66% of the total population were fully vaccinated, and approximately 76% of eligible Canadians 12 years and older were fully vaccinated [9]. Given that only those 12 years and older are eligible for vaccination, the percentage of vaccinated individuals will vary from classroom to classroom.

- For kindergarten classes, only teachers and staff are presently eligible for vaccination. Depending on whether vaccines are mandatory for teachers and staff, there may be a mix of vaccinated and unvaccinated adults in kindergarten classrooms. At present, no kindergarten-age students are eligible for vaccination.

- Elementary schools also have a mix of those who are (a) below the age of 12, and therefore ineligible for vaccination, (b) eligible and vaccinated, and (c) eligible and unvaccinated.

- For high schools and post-secondary institutions, all students and staff are eligible for a COVID-19 vaccine, but absent mandatory vaccination policies, there is a mix of vaccinated and unvaccinated

adults in secondary and post-secondary classrooms. A number of post-secondary institutions have mandated vaccination for students and staff.[19–21]

The difference between vaccine eligibility and vaccine uptake among these three groups will require different approaches to public health measures.

Cohorts: Most kindergarten and elementary schools organize students into cohorts, which are groups of students who take their courses together in the same classroom. By contrast, high school and post-secondary students are generally not organized into cohorts, meaning that their classmates and teachers/professors vary from course to course. This has an impact on the size and nature of contacts and affects the transmission and spread of SARS-CoV-2 in different ways. For example, students organized into cohorts will generally have fewer contacts than those not organized into cohorts, which can reduce the spread of SARS-CoV-2 and assist with contact tracing.[1] However, in their recent report, the Ontario Science Advisory Table notes that cohorts may "not be optimal for [high school student's] learning and social interactions".[1]

The Impact of School Closures

Learning and development

School closures should be an exceptional public health measure, invoked only in "catastrophic" circumstances and should be the "first to open and last to close".[1,8] This is because in-person education is essential for students' learning, socialization, and wellbeing. Specifically, closures of kindergarten, elementary, and secondary schools have led to the following impacts [1,8,13]:

- disruptions and losses in learning;
- disengagement;
- negative impacts on physical and mental health;
- disproportionate impacts on vulnerable populations;
- delays in building skills;
- loss of access to essential programs for children with disabilities and for vulnerable populations; and
- detection and reporting of child maltreatment and neglect.

Although the impact of school closures on post-secondary students has not yet been fully addressed in the scientific literature, it may include (in addition to the above):

- hindered student-student and student-professor interactions;
- increased difficulty in the transition to and from post-secondary institutions;
- delays in the completion of professional programs and practicums;
- delays in graduation; and

- increased deferrals among those beginning new academic programs.

The impact of school closures on parents and the economy

School closures and remote learning have also had a negative impact on parents and on the economy. According to the Ontario Science Advisory Table, "schools play a key role in enabling parents to work, particularly promoting labour participation of women and front-line service workers".[1] School closures and remote learning require parents to balance their children's education with their own jobs and/or other responsibilities. Furthermore, "modeling data [suggests that school closures have] an impact on future lifetime earnings [and a] reduced participation in the labour force by parents, particularly, mothers".[22]

Key Considerations for Lifting and Introducing Public Health Measures in Schools

The "Swiss Cheese" Model

Layering several imperfect interventions could lead to a desirable outcome, e.g. reducing the spread of SARS-CoV-2. The idea is to get many imperfect layers of protection, that line up in a way to help diminish the number of "holes" and therefore, decrease the ability for the virus to spread. This has been commonly referred to as the "Swiss Cheese Model".[23,24]

This approach of implementing multiple effective public health measures should be adopted in schools. A United Kingdom modeling study investigating the impact of re-opening a university on COVID-19 transmission found that layering multiple interventions could reduce infection rates by 75%.[25]

Key measures to layer include vaccination of those who are eligible, testing, surveillance, adequate ventilation, masking, physical distancing, cohorting, contact tracing, isolation, and quarantine. These will be explained in detail below.

Transmission of the Delta variant (B.1.617.2)

The Delta variant has been surging in Canada and across the globe and is highly transmissible compared to the original SARS-CoV-2 strain. It is suggested that the reason for its increase in transmission and spread is the higher amount of viral load that is produced by those who are infected with the Delta variant (B.1.617.2).[26,27] Vaccination is a key public health measure to minimize serious illness from COVID-19 and spread, although, while reduced, some transmission may still occur among the vaccinated.[3–5] The Delta variant is much more transmissible (estimated basic reproduction number R_0 of 6-8), partially evades immunity (resulting in waning protection against breakthrough infections over time), and potentially results in viral loads in the upper respiratory tract of individuals with breakthrough infections that are comparable to those of infected unvaccinated people.[28,29] This suggests that vaccinated people

will also contribute to the spread of the Delta variant and could therefore infect those who are unvaccinated (including those under the age of 12).

Given that the majority of schools and post-secondary institutions were virtual for the 2020-2021 academic period and when the Delta variant was surging and vaccinations increased, there is currently scant data on how transmission will play out in schools and post-secondary institutions across Canada. A pre-print focusing on data in Ontario, Canada found that the Delta variant, compared to the original COVID-19, more than doubled hospitalization risk for children under the age of 10.[30] Further, among younger adult groups, the Delta variant was associated with significant increases in risk in hospitalization, ICU admission, and death.[30]

Key metrics to be considered for lifting and introducing public health measures

The literature identifies three key metrics that should be considered when lifting or introducing public health measures in schools: vaccination rates in the community where the school is situated; metrics of disease severity including deaths, hospitalizations, hospital bed occupancy, and intensive care unit (ICU) capacities due to COVID-19; and SARS-CoV-2 transmission in schools and the community where the school is situated.[1,31]

1. Local vaccination rates: Vaccination is the most effective public health measure as it may reduce the spread of SARS-CoV-2 (although emerging evidence is suggesting that transmission may even occur among the vaccinated) and reduce severe health outcomes due to COVID-19.[1] Increased vaccination rates are expected to reduce the circulation of SARS-CoV-2 among unvaccinated youth, leading to fewer cases and outbreaks in schools. Of concern is how the Delta variant will affect the spread of SARS-CoV-2 among the unvaccinated—particularly children—despite high vaccination rates among those eligible.

2. Metrics of serious COVID-19: Key metrics include numbers of hospital bed occupancy, ICU bed occupancy, and deaths due to COVID-19. As vaccination rates increase, we can expect a reduction in the number of deaths from COVID-19, and a decreased burden on the health care system.[1] This, however, depends on the effect of VOCs especially the Delta variant that is more infectious and surging across Canada. A CDC study observed an increase in COVID-19 cases and hospitalizations among children and adolescents (0-17 years old) between June 2021 and August 2021.[32] Another found that between March 2020 and August 2021, the COVID-19-associated hospitalizations per 100,000 children and adolescents were highest among children ages 0-4 years, followed by adolescents aged 12-17, and then children 5-11 years of age.[33] Furthermore, hospitalization rates rose about 10 times among children and adolescents after the Delta variant became dominant, while rates of severe disease were similar between pre-Delta and Delta circulation.[33]

3. SARS-CoV-2 transmission: SARS-CoV-2 is predominantly transmitted by aerosols and respiratory droplets.[1,34,35] The metrics that quantify transmission includes the effective reproductive number and the daily number of positive cases.[2] Given that metrics of serious COVID-19 are lagging indicators (i.e. about 1-3 weeks), using measures of SARS-CoV-2 transmission could help determine when to re-implement public health measures in schools.

The Ontario Science Advisory Table report lists various public health measures that are essential for the response to the COVID-19 pandemic and beyond. Table 1 provides a summary of (a) permanent measures or measures that should be kept during and beyond the pandemic; and (b) temporary measures or those that should be introduced or lifted based on the local pandemic situation and the above three metrics, in kindergarten, elementary, and secondary schools.[1]

Table 1: Permanent and temporary public health measures to be implemented in schools as outlined in the Ontario Science Advisory Table Brief on the 2021-2022 academic year

Permanent measures[a]	Temporary measures[b]
• **Vaccination** • **Hand hygiene** • **Employees and students staying home when sick and paid sick days (staff)** • **Ventilation/indoor air quality** • **Sanitation and environmental cleaning** • **Smaller class sizes** • **Contact tracing**	• Symptom and exposure screening • Masks • Cohorts • Outdoor learning • Diagnostic testing • Screening testing • Physical distancing

[a] Permanent measures are measures that should be sustained during and post-pandemic, as these are effective public health measures that help reduce the spread of SARS-CoV-2 and other infectious diseases.
[b] Temporary measures are those that are to be introduced or lifted in response to the COVID-19 situation and based on local vaccination rates, metrics of COVID-19 severity, and SARS-CoV-2 transmission.

Key public health measures to be prioritized in schools

1. Vaccination

Vaccines contribute to curbing the transmission of SARS-CoV-2 and are most effective in reducing severe health outcomes. Accordingly, priority should be placed on encouraging and promoting vaccination for all eligible individuals. Vaccine delivery should strive to reduce barriers to access vaccines (e.g. by creating vaccine centres or mobile units near schools).[1,2]

Community vaccination rates may be 'critical' to protecting children and adolescents from COVID-19, hospitalization, and severe outcomes. Within a 2-week period, children and adolescents with COVID-19 living in US states with lowest vaccination rates had 4 times more hospitalizations compared to children and adolescents living in states with higher vaccination rates.[32] With the Delta variant rapidly circulating across Canada and that adolescents are susceptible to severe COVID-19 outcomes, encouraging the 12-17 year old population to get vaccinated (and gain support by their parents) is "crucial to a safer return to the classroom" according to the CDC.[36]

Implementing mandatory vaccination policies can also be an effective way to encourage vaccination and reduce SARS-CoV-2 transmission/serious outcomes of COVID-19. Many post-secondary schools in Canada have mandated COVID-19 vaccination for all teachers, students, and staff, or they require that those who are unvaccinated participate in frequent testing. Some kindergarten, elementary, and secondary schools have also implemented similar mandates for teachers and staff. Certain provinces, like Ontario, are also considering mandatory vaccination for all eligible children ages 12 years and older, with exemptions for medical and religious reasons.[37]

Vaccines may not be fully protective against infection, especially with the Delta variant, and that protection against infection will wane over time.[38,39] This emphasizes the importance of layering multiple measures in schools and post-secondary institutions to minimize the spread of COVID-19.

2. Testing, screening, and surveillance

Students and staff should routinely undergo symptom screenings prior to attending in-person learning, a practice that should extend beyond the COVID-19 pandemic.[1,13,31,40] Symptom screening brings individual awareness to possible COVID-19 symptoms and helps students and staff determine whether they should attend school in-person. Anyone experiencing symptoms should be required to self-isolate and promptly be tested for SARS-CoV-2 by PCR.

There are three types of diagnostic testing available in Canada [41–46]:

a) Nucleic Acid-based Testing (also called polymerase chain reaction or PCR testing) – this is widely viewed as the 'gold standard';

b) Rapid Molecular Testing (e.g. Abbott ID NOW), an in vitro diagnostic test that uses an isothermal nucleic acid amplification technology to detect SARS-CoV2; and

c) Antigen-based Testing (known as rapid antigen detection test or RADT) – can be used as screening testing in high-risk contexts and where rapid results are important. It is less sensitive than the lab-based PCR testing, but faster and can provide more information than symptom screening alone. If

used in settings with lower prevalence of infection in the community, false positive results will likely occur.[47] A confirmatory test by PCR is warranted for positive antigen testing results and, as above, a PCR test should be used for those with symptoms. Given the lower sensitivity of the test, testing should be done frequently for it to be effective – this, however, depends on the strain of SAR-CoV-2 circulating in the community.[47]

The Delta variant (which is the most dominant strain circulating across Canada) is much more transmissible; studies have shown that viral loads are much higher in the noses of those infected with the Delta variant compared to other VOCs.[27,48,49] Although rapid antigen tests are less sensitive than the gold standard lab-based PCR test, the lower the Ct values (in turn associated with the higher viral load) in the upper respiratory tract of those infected, the higher the sensitivity of the test.[49–52] Therefore, rapid antigen tests (or self-tests) may be an alternative testing strategy to detect Delta infections.[49] Table 2 provides a summary of the types of COVID-19 testing and their characteristics including the types of specimens and how they are collected and processed, as well as the turnaround time to receive test results.

Table 2: Summary of available COVID-19 testing* and their characteristics [42–46]

	PCR Test – most accurate	**Rapid Molecular Test**	**Rapid Antigen Test – accuracy depends on variant**
Specimen	Nasal swabs, shallow or deep (most tests) Saliva (some tests)	Nasal swabs, nasopharyngeal or throat swabs	Nasal or nasopharyngeal swab (most tests)
Turnaround time	1-2 days	Fast (15 minutes)	Fast (15–30 minutes), depending on the test
Where do they get collected?	Testing centre Hospital or doctor's office (rapid point-of-care)	Hospital or doctor's office (rapid point-of-care)	Hospital or doctor's office (rapid point-of-care) Self-test performed independently
Where do they get processed?	Laboratory Hospital or doctor's office (rapid point-of-care)	Hospital or doctor's office (rapid point-of-care)	Hospital or doctor's office (rapid point-of-care); home tests may be available in the future Self-test performed independently

*Tests that are currently approved by Health Canada

It is widely accepted that all students and staff with COVID-19 symptoms should be tested with the more sensitive lab-based PCR diagnostic test.[1,40] Rapid antigen testing can provide an extra layer of protection. It can also limit the transmission of SARS-CoV-2 in settings where there is a high prevalence of SARS-

CoV-2 and more infectious VOCs with more rapid identification of positive cases with the potential for ongoing transmission that may not otherwise be detected. At home and on-site testing could also offer more convenience which may lead to a higher uptake of testing.[6] Modeling studies suggest that rapid testing at least weekly, with rapid contact tracing, may result in reduced transmission.[7] Further, the CDC recommends that post-secondary schools implement a "robust, frequent SARS-CoV-2 screening testing program with high participation from the unvaccinated".[2] It is also recommended for students involved in sports and other activities, where public health measures cannot be maintained including physical distancing and mask wearing.[1,2,53]

There are several recommendations regarding the use of rapid testing in kindergarten, elementary, and secondary schools. These recommendations can also be applied to post-secondary schools. They include [1,40]:

a) The implementation of rapid testing; the frequency of screening tests should be guided by the community prevalence of SARS-CoV-2, outbreak status of the school, and the presence of VOCs.

b) Implementation of this measure should not take away from other more important public health measures and should be specific to the local community's context.

c) Rapid tests are less sensitive than the gold standard PCR testing, but they provide timely results.

d) All rapid tests with positive results should be followed up with a standard PCR test for verification.

e) Rapid tests may be a good alternative in settings where diagnostic testing is constrained and used for lower risk contacts.

f) Consider the Test-to-Play strategies for children to participate in extracurricular close contact sports and athletics.

g) Prior to implementing, logistical and equity considerations are essential.

There are other less invasive sampling methods that may be considered for children. These methods include the swish-and-gargle saltwater method, spit samples, and nasal sample collections.[40,54] Pooled saliva testing may also be considered in settings with low community prevalence. Currently, these alternative specimens are mainly processed via lab-based PCR, with the exception of nasal sample collections.[40,54]

3. Ventilation and air quality

It has been well-documented that good ventilation is important for our well-being – when ventilation is poor, studies have shown that there is a reduction in worker productivity, reduction in student learning, and serious health concerns.[1,55,56]

Adequate ventilation, when coupled with other key public health measures, reduces SARS-CoV-2 transmission in schools given it is primarily transmitted by aerosols and respiratory droplets.[1,34,35,57–59] SARS-CoV-2 spreads much more readily indoors.[60] Good indoor ventilation will reduce particle concentration.[60] Schools should therefore invest in adequate ventilation, as it is an important measure for reducing SARS-CoV-2 transmission (and other infectious diseases) indoors as well as improving the health and learning of students.

With limited funding, many schools have updated their ventilation systems to make indoor learning for students safer. It should be well-communicated to school boards and districts that ventilation is only one line of defense against the virus, and it alone cannot prevent virus spread in schools given the importance of layering effective, but imperfect, public health measures.[1,61]

4. Masking

Wearing a well-fitted non-medical or medical mask is an important source control of SARS-CoV-2 between people, and only works if everyone wears them.[1,62,63] With the Delta variant surging, the CDC underscores the importance of universal indoor mask wearing, even among the fully vaccinated, in schools grades K to12 and all other indoor settings in areas of substantial or high transmission, to reduce SARS-CoV-2 transmission and severe outcomes in children.[33,48]

5. Other public health measures

The following public health measures have been widely accepted as key public health measures to be implemented and encouraged in schools, depending on the local pandemic situation and key metrics discussed above. They include [1,2,31,53,64]:

a) Staying home when sick (staff and students)
b) Physical distancing
c) Use of cohorts
d) Hand-hygiene[1]
e) Sanitation/environmental cleaning[2]

[1] SARS-CoV-2 transmission via fomites is not the primary role of transmission, but hand-hygiene may prevent the spread of other diseases.
[2] SARS-CoV-2 transmission via fomites is not the primary role of transmission, but sanitation/environmental cleaning may prevent the spread of other diseases.

f) Wastewater surveillance
g) Use of isolation facilities, especially in post-secondary schools
h) Outdoor learning
i) Smaller class sizes
j) Contact tracing, isolation, and quarantine

Knowledge Gaps and Future Research

We identified several knowledge gaps and recommendations for future research regarding the introduction of public health measures for kindergarten, elementary, secondary, and post-secondary schools. Particularly:

a) Future research should assess the impact of VOCs on SARS-CoV-2 transmission on campuses, as well as assess their impact on the effectiveness of infection prevention and control strategies.[7]

b) As people become fully vaccinated, further research will be required to determine the thresholds and implications of any proposed reduction or relaxation of public health measures for populations or communities to minimize future spread.[3] However, as new variants emerge over the course of the pandemic, the need for continued public health measures in addition to vaccines is likely for the foreseeable future until a substantial proportion of the global population is fully vaccinated.

c) Future research should investigate the impacts of school closures on post-secondary students on their careers and academic learning.

d) Future research should “invest in comprehensive population-based follow-up studies” to accurately understand the impact of school closures on children and youth.[8]

e) Future research should investigate the diagnostic performance of rapid tests in detecting infections with the Delta variant.

f) Finally, research should investigate the impact of the rollout of rapid tests on the rest of outbreaks and infections in elementary, secondary, and post-secondary schools testing.

Limitations

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were consulted. Finally, given the rapid timeframe for this report, some relevant information may have been missed.

Conclusion

This Issue Note provides a set of key considerations for determining which public health measures should be kept or introduced within kindergarten, elementary schools, high schools, and post-secondary schools, as presented by existing guidelines, briefings, and expert opinions. Future research should assess the impact of the Delta variant, and other variants of concern on SARS-CoV-2 in schools, and their impact on the effectiveness of infection prevention and control strategies.

References

1. Science M, Thampi N, Bitnun A, Allen U, Birken C, Blackman N, et al. School Operation for the 2021-2022 Academic Year in the Context of the COVID-19 Pandemic [Internet]. Ontario COVID-19 Science Advisory Table; 2021 Jul [cited 2021 Aug 27]. Available from: https://covid19-sciencetable.ca/sciencebrief/school-operation-for-the-2021-2022-academic-year-in-the-context-of-the-covid-19-pandemic

2. Centers for Disease Control and Prevention. Guidance for Institutions of Higher Education (IHEs) [Internet]. Centers for Disease Control and Prevention; 2020 Feb [cited 2021 Aug 27]. (Community, Work, & School). Available from: https://www.cdc.gov/coronavirus/2019-ncov/community/colleges-universities/considerations.html

3. Centers for Disease Control and Prevention. Science Brief: COVID-19 Vaccines and Vaccination [Internet]. 2021 Sep. Available from: https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/fully-vaccinated-people.html

4. Public Health Ontario. Evidence Brief: Risk of COVID-19 Transmission from Vaccinated Cases [Internet]. 2021 Jun. Available from: https://www.publichealthontario.ca/-/media/documents/ncov/phm/2021/06/covid-19-transmission-vaccinated-cases.pdf?sc_lang=en

5. Harris RJ, Hall JA, Zaidi A, Andrews NJ, Dunbar JK, Dabrera G. Effect of Vaccination on Household Transmission of SARS-CoV-2 in England. N Engl J Med [Internet]. 2021 Aug 19 [cited 2021 Oct 13];385(8):759–60. Available from: https://doi.org/10.1056/NEJMc2107717

6. Health Canada. Priority strategies to optimize self-testing in Canada [Internet]. Government of Canada; 2021 Aug. Report No.: 978-0-660-39975–1. Available from: https://www.canada.ca/en/health-canada/services/drugs-health-products/covid19-industry/medical-devices/testing-screening-advisory-panel/reports-summaries/self-testing.html#a4

7. The National Collaborating Centre for Methods and Tools. Rapid Review: What is known about the risk of transmission of COVID-19 within post-secondary institutions and the strategies to mitigate on-campus outbreaks? [Internet]. 2021 [cited 2021 Aug 27]. Available from: https://www.nccmt.ca/uploads/media/media/0001/02/91dbea46885b930b0c0f9bb66258321e8d7565d5.pdf

8. Royal Society of Canada. Children and Schools During COVID-19 and Beyond: Engagement and Connection Through Opportunity [Internet]. 2021 Aug [cited 2021 Sep 5]. Available from: https://rsc-src.ca/en/covid-19-policy-briefing/children-and-schools-during-covid-19-and-beyond-engagement-and-connection

9. Vaccination Tracker. COVID-19 Vaccination Tracker [Internet]. Available from: https://covid19tracker.ca/vaccinationtracker.html

10. Government of Canada. COVID-19 daily epidemiology update [Internet]. Available from: https://health-infobase.canada.ca/covid-19/epidemiological-summary-covid-19-cases.html

11. Polisena J, Ospina M, Sanni O, Matenchuk B, Livergant R, Amjad S, et al. Public health measures to reduce the risk of SARS-CoV-2 transmission in Canada during the early days of the COVID-19 pandemic: a scoping review. BMJ Open [Internet]. 2021 Mar [cited 2021 May 28];11(3):e046177. Available from: https://bmjopen.bmj.com/lookup/doi/10.1136/bmjopen-2020-046177

12. Institut National de Sante Publique du Quebec. COVID-19 : Impacts de la pandémie sur le développement des enfants de 2 à 12 ans [Internet]. 2021 Jul. Available from: https://www.inspq.qc.ca/sites/default/files/publications/3157-impacts-pandemie-developpement-enfants-2-12-ans.pdf

13. British Columbia Centre for Disease Control, British Columbia Ministry of Health. Public Health Guidance for K-12 Schools: Outlook for the 2021-22 School Year. 2021.

14. Statistics Canada. Postsecondary graduates, by location of residence at interview and level of study [Internet]. [cited 2021 Aug 25]. Available from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3710003101

15. Fisman DN, Greer AL, Hillmer M, O'Brien SF, Drews SJ, Tuite AR. COVID-19 Case Age Distribution: Correction for Differential Testing by Age. 2020 Sep 18 [cited 2021 Aug 27];2020.09.15.20193862. Available from: https://www.medrxiv.org/content/10.1101/2020.09.15.20193862v1

16. Centers for Disease Control and Prevention. Outbreak Associated with SARS-CoV-2 B.1.617.2 (Delta) Variant in an Elementary School — Marin County, California, May–June 2021 [Internet]. 2021 Sep. (Morbidity and Mortality Weekly Report). Available from: https://www.cdc.gov/mmwr/volumes/70/wr/mm7035e2.htm

17. Callaway E. COVID vaccine boosters: the most important questions. 2021 Aug 5; Available from: https://www.nature.com/articles/d41586-021-02158-6

18. Yin S, Barnes K, Fisher R, Terashita D, Kim AA. COVID-19 Case Rates in Transitional Kindergarten Through Grade 12 Schools and in the Community — Los Angeles County, California, September 2020–March 2021 [Internet]. 2021 Sep. Available from: https://www.cdc.gov/mmwr/volumes/70/wr/mm7035e3.htm?s_cid=mm7035e3_w

19. CBC News. N.S. working on proof-of-vaccine strategy for those entering the province. CBC News [Internet]. 2021 Jun 2 [cited 2021 Jun 11]; Available from: https://www.cbc.ca/news/canada/nova-scotia/proof-of-vaccine-nova-scotia-self-isolation-waived-entering-province-1.6050404

20. The Canadian Press. Manitoba universities and college mandate COVID-19 vaccines for staff, students. 2021 Aug 19; Available from: https://www.theglobeandmail.com/canada/article-manitoba-universities-and-college-mandate-covid-19-vaccines-for-staff/

21. De Luigi E. More Ontario universities strengthen campus COVID-19 vaccination policies. 2021 Aug 26; Available from: https://www.theglobeandmail.com/canada/article-more-ontario-universities-strengthen-campus-vaccination-policies/

22. Gallagher-Mackay K. COVID-19 and Education Disruption in Ontario: Emerging Evidence on Impacts. 2021 Jun.

23. Reason J. Human error: models and management. BMJ [Internet]. 2000 Mar 18;320(7237):768–70. Available from: https://pubmed.ncbi.nlm.nih.gov/10720363

24. D'Amore R. What is the 'Swiss cheese model' and how can it apply to coronavirus? Global News [Internet]. 2020 Oct 13 [cited 2021 Sep 13]; Available from: https://globalnews.ca/news/7393839/coronavirus-swiss-cheese-model/

25. Brooks-Pollock E, Christensen H, Trickey A, Hemani G, Nixon E, Thomas AC, et al. High COVID-19 transmission potential associated with re-opening universities can be mitigated with layered interventions. Nature Communications [Internet]. 2021 Aug 17;12(1):5017. Available from: https://doi.org/10.1038/s41467-021-25169-3

26. Reardon S. How the Delta variant achieves its ultrafast spread [Internet]. 2021 Jul. (Nature). Available from: https://www.nature.com/articles/d41586-021-01986-w#ref-CR1

27. Li B, Deng A, Li K, Hu Y, Li Z, Xiong Q, et al. Viral infection and transmission in a large, well-traced outbreak caused by the SARS-CoV-2 Delta variant. medRxiv [Internet]. 2021 Jan 1;2021.07.07.21260122. Available from: http://medrxiv.org/content/early/2021/07/23/2021.07.07.21260122.abstract

28. Subbaraman N. How do vaccinated people spread Delta? What the science says [Internet]. 2021 Aug [cited 2021 Sep 13]. Available from: https://www.nature.com/articles/d41586-021-02187-1

29. Riemersma KK, Grogan BE, Kita-Yarbro A, Halfmann PJ, Segaloff HE, Kocharian A, et al. Shedding of Infectious SARS-CoV-2 Despite Vaccination. medRxiv [Internet]. 2021 Jan 1;2021.07.31.21261387. Available from: http://medrxiv.org/content/early/2021/08/24/2021.07.31.21261387.abstract

30. Fisman DN, Tuite AR. Age-Specific Changes in Virulence Associated with SARS-CoV-2 Variants of Concern. medRxiv [Internet]. 2021 Sep 27;2021.09.25.21264097. Available from: http://medrxiv.org/content/early/2021/09/27/2021.09.25.21264097.abstract

31. British Columbia Post-Secondary Institutions. COVID-19 Return-to-Campus Guidelines. 2021 Oct 25;18. Available from: https://www2.gov.bc.ca/assets/gov/education/post-secondary-education/institution-resources-administration/covid19-return-to-campus-guidelines-web.pdf

32. Morbidity and Mortality Weekly Report. 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. 2021 Sep 3 [cited 2021 Sep 8]; Available from: https://www.cdc.gov/mmwr/volumes/70/wr/mm7036e1.htm

33. Centers for Disease Control and Prevention. Hospitalizations Associated with COVID-19 Among Children and Adolescents — COVID-NET, 14 States, March 1, 2020–August 14, 2021 [Internet]. 2021 Sep [cited 2021 Sep 8]. Available from: https://www.cdc.gov/mmwr/volumes/70/wr/pdfs/mm7036e2-H.pdf

34. Vuorinen V, Aarnio M, Alava M, Alopaeus V, Atanasova N, Auvinen M, et al. Modelling aerosol transport and virus exposure with numerical simulations in relation to SARS-CoV-2 transmission by inhalation indoors. Safety science. 2020;130:104866–104866.

35. Somsen GA, van Rijn C, Kooij S, Bem RA, Bonn D. Small droplet aerosols in poorly ventilated spaces and SARS-CoV-2 transmission. The Lancet Respiratory Medicine [Internet]. 2020 Jul 1 [cited 2021 Sep 8];8(7):658–9. Available from: https://doi.org/10.1016/S2213-2600(20)30245-9

36. Centers for Disease Control and Prevention. COVID-19 Vaccination Coverage Among Adolescents Aged 12–17 Years — United States, December 14, 2020–July 31, 2021 [Internet]. 2021 Sep [cited 2021 Sep 9]. Available from: https://www.cdc.gov/mmwr/volumes/70/wr/mm7035e1.htm

37. Holly McKenzie-Sutte. Education group wants COVID-19 vaccination required for eligible Ontario students. Global News [Internet]. 2021 Aug 23; Available from: https://globalnews.ca/news/8134345/education-group-covid-vaccine-requirement-ontario-students/

38. Sanderson K. COVID vaccines protect against Delta, but their effectiveness wanes [Internet]. 2021 Aug [cited 2021 Sep 13]. (Nature). Available from: https://www.nature.com/articles/d41586-021-02261-8

39. Pouwels KB, Pritchard E, Matthews PC, Stoesser N, Eyre DW, Vihta K-D, et al. Impact of Delta on viral burden and vaccine effectiveness against new SARS-CoV-2 infections in the UK. medRxiv [Internet]. 2021 Jan 1;2021.08.18.21262237. Available from: http://medrxiv.org/content/early/2021/08/24/2021.08.18.21262237.abstract

40. Canada H. Priority strategies to optimize testing and screening for primary and secondary schools [Internet]. 2021 Mar [cited 2021 Aug 27]. Available from: https://www.canada.ca/en/health-canada/services/drugs-health-products/covid19-industry/medical-devices/testing-screening-advisory-panel/reports-summaries/primary-secondary-schools.html

41. Evidence Synthesis Network. Sensitivity Use of Rapid Antigen Tests for SARS-CoV-2 Delta Variant [Internet]. 2021 Sep. Available from: https://esnetwork.ca/wp-content/uploads/2021/09/74.-ESBN-on-Rapid-Ag-Tests-for-SARS-CoV-2-Delta-Variant_22-SEPT-2021-V1.pdf

42. FDA U.S. Food & Drug Administration. Coronavirus Disease 2019 Testing Basics [Internet]. 2021 Apr [cited 2021 Sep 10]. Available from: https://www.fda.gov/media/140161/download

43. Government of Canada. Testing devices for COVID-19: Overview [Internet]. 2021 May [cited 2021 Sep 10]. Available from: https://www.canada.ca/en/health-canada/services/drugs-health-products/covid19-industry/medical-devices/testing.html

44. Government of Canada. Pan-Canadian COVID-19 Testing and Screening Guidance: Technical guidance and implementation plan [Internet]. 2021 Aug [cited 2021 Sep 10]. Available from: https://www.canada.ca/en/health-canada/services/drugs-health-products/covid19-industry/medical-devices/testing/pan-canadian-guidance.html

45. FDA U.S. Food & Drug Administration. ID NOW COVID-19 [Internet]. 2021 Aug [cited 2021 Sep 14]. Available from: https://www.fda.gov/media/136525/download

46. Public Health Agency of Canada. Interim guidance on the use of the Abbott ID NOW™ instrument and COVID-19 assayon behalf of the Cana [Internet]. 2020 Nov [cited 2021 Sep 14]. Available from: https://www.canada.ca/content/dam/phac-aspc/documents/services/reports-publications/canada-communicable-disease-report-ccdr/monthly-issue/2020-46/issue-11-12-nov-5-2020/ccdrv46i1112a09-eng.pdf

47. Centers for Disease Control and Prevention. Interim Guidance for Antigen Testing for SARS-CoV-2 [Internet]. 2021 Sep. Available from: https://www.cdc.gov/coronavirus/2019-ncov/lab/resources/antigen-tests-guidelines.html

48. Centers for Disease Control and Prevention. Delta Variant: What We Know About the Science [Internet]. 2021 Aug [cited 2021 Sep 9]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/variants/delta-variant.html

49. Medscape. The Delta Variant in Schools: Is Rapid Testing the Answer? [Internet]. 2021 Aug. Available from: https://www.medscape.com/viewarticle/955795#vp_2

50. Sood N, Shetgiri R, Jimenez D, Treminino S, Daflos A, Simon P. Evaluation of the Abbott BinaxNOW rapid antigen test for SARS-CoV-2 infection in children: Implications for screening in a school setting. 2021 Apr 5; Available from: https://journals.plos.org/plosone/article/metrics?id=10.1371/journal.pone.0249710

51. Pollock Nira R., Jacobs Jesica R., Tran Kristine, Cranston Amber E., Smith Sita, O'Kane Claire Y., et al. Performance and Implementation Evaluation of the Abbott BinaxNOW Rapid Antigen Test in a High-Throughput Drive-Through Community Testing Site in Massachusetts. Journal of Clinical Microbiology [Internet]. [cited 2021 Sep 14];59(5):e00083-21. Available from: https://doi.org/10.1128/JCM.00083-21

52. García-Fiñana M, Hughes DM, Cheyne CP, Burnside G, Stockbridge M, Fowler TA, et al. Performance of the Innova SARS-CoV-2 antigen rapid lateral flow test in the Liverpool asymptomatic testing pilot: population based cohort study. BMJ [Internet]. 2021 Jul 7;374:n1637. Available from: http://www.bmj.com/content/374/bmj.n1637.abstract

53. Centers for Disease Control and Prevention. Operational Strategy for K-12 Schools through Phased Prevention [Internet]. Centers for Disease Control and Prevention; 2020 Feb [cited 2021 Aug 27]. (Community, Work, & School). Available from: https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/operation-strategy.html

54. Centers for Disease Control and Prevention. Interim Guidance for Use of Pooling Procedures in SARS-CoV-2 Diagnostic and Screening Testing. 2021 Jun.

55. Vakalis D, Lepine C, MacLean HL, Siegel JA. Can green schools influence academic performance? null [Internet]. 2021 Jul 3;51(13):1354–96. Available from: https://doi.org/10.1080/10643389.2020.1753631

56. Seppanen O. Scientific basis for design of ventilation for health, productivity and good energy efficiency [Internet]. 2008 [cited 2021 Sep 14]. Available from: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.575.7723&rep=rep1&type=pdf

57. Leclerc Q, Fuller N, Knight L, Funk S, Knight G. What settings have been linked to SARS-CoV-2 transmission clusters? [version 2; peer review: 2 approved]. Wellcome Open Research [Internet]. 2020;5(83). Available from: https://wellcomeopenresearch.org/articles/5-83/v2

58. Public Health Agency of Canada. COVID-19: Guidance on indoor ventilation during the pandemic [Internet]. [cited 2021 Sep 9]. Available from: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/guide-indoor-ventilation-covid-19-pandemic.html

59. Morbidity and Mortality Weekly Report. Mask Use and Ventilation Improvements to Reduce COVID-19 Incidence in Elementary Schools — Georgia, November 16–December 11, 2020 [Internet]. 2021 May [cited 2021 Sep 9]. Available from: https://www.cdc.gov/mmwr/volumes/70/wr/mm7021e1.htm?s_cid=mm7021e1_w

60. Centers for Disease Control and Prevention. Ventilation in Buildings [Internet]. 2021 Jun [cited 2021 Sep 9]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html

61. Office of the Chief Science Advisor of Canada. The Role of Bioaerosols and Indoor Ventilation in COVID-19 Transmission [Internet]. 2020 Sep [cited 2021 Sep 7]. Available from: https://www.ic.gc.ca/eic/site/063.nsf/eng/h_98176.html

62. Chu DK, Akl EA, Duda S, Solo K, Yaacoub S, Schünemann HJ, et al. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. The Lancet [Internet]. 2020 Jun 27 [cited 2021 Sep 13];395(10242):1973–87. Available from: https://doi.org/10.1016/S0140-6736(20)31142-9

63. Prather Kimberly A., Wang Chia C., Schooley Robert T. Reducing transmission of SARS-CoV-2. Science [Internet]. 2020 Jun 26 [cited 2021 Sep 13];368(6498):1422–4. Available from: https://doi.org/10.1126/science.abc6197

64. McMaster Health Forum, COVID-19 Evidence Network to support Decision-making in Canada. COVID-19 Living Evidence Profile #3 What is known about how schools (K-12) and post-secondary institutions (colleges and universities) adjust COVID-19 transmission-mitigation measures as infection rates change and vaccination rates increase? [Internet]. 2021 Jun. Available from: https://www.mcmasterforum.org/docs/default-source/product-documents/living-evidence-profiles/covid-19-living-evidence-profile-3.2_what-is-known-about-how-schools-and-post-secondary-institutions-adjust-covid-19-transmission-mitigation-measures-as-infection-rates-change-and-vaccination-rates-increase.pdf?sfvrsn=d9b11380_21

Appendix

Table 3: List of experts consulted

Consultations	Affiliations
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Nisha Thampi, MD, MSc	Assistant Professor and Pediatric Infectious Diseases Consultant University of Ottawa