# Emerging Evidence on COVID-19

# Evidence Brief on SARS-CoV-2 Variants of Concern and Transmission in Children

## Introduction

*What is the global evidence on whether SARS-CoV-2 variants of concern (VOCs) have changed transmission in children and transmission patterns in schools?*

Several SARS-CoV-2 variants of concern (VOCs) have been identified since December 2020. As of March 26, 2021, these included B.1.1.7, B.1.351, P.1 (1) and B.1.429 (2) which have acquired enhanced infectivity and transmissibility. The new variants have quickly spread to many countries globally and are being intensely studied to understand their clinical and epidemiological impacts. This evidence brief identifies and summarizes the existing evidence up to March 26, 2021 on transmission of the VOCs in children and the impact on in-school transmission.

## Key Points

- Web-scraped media data of school related COVID-19 outbreaks across Canada indicate that an increasing number of VOC related school outbreaks have been reported from January to March 2021.
- Overall, nine studies were identified COVID-19 VOC transmission in children. Of these, five focused only on transmission of VOCs in children, three assessed transmission patterns in schools and one study evaluated both (Tables 1 and 2). Currently, all studies focused on B.1.1.7 transmission patterns in children in the UK during November 2020 to January 2021 as the proportion of cases associated with B.1.1.7 increased steadily from the end of November onward (3).
- Five studies found that B.1.1.7 does not disproportionately affect children (<11 years old) and youth (11-19 years old). The increased transmissibility of the variant is observed in both adults and children, which suggested that the variant is not particularly adapted to any age group. A modelling study as well as epidemiological evidence of B.1.1.7 transmission in the UK identified that VOC transmission was not driven by children.
    - A single study reported that there were increased cases of B.1.1.7 in children and youth <20 years compared to older adults (> 70 years). However, schools remained open

during the community lockdown, which would result in school-age children having higher contact rates and risk of being exposed compared to adults over 70 years (4).

- Among children and young people hospitalized, there was no evidence of more severe disease (e.g., requiring ventilation support) with B.1.1.7 infection. This suggested that clinical course does not differ appreciably.
- Evidence identified that transmission in school-aged children was strongly correlated with the level of community transmission.
    - None of the studies estimated the likelihood of school outbreaks associated with VOCs compared to the original SARS-CoV-2 variant.
    - There was no evidence identified that schools were playing a large role in driving B.1.1.7 transmission in the community (5).
    - There was a reduction of cases in children and youth following school closures which may be due to both a reduction in cases and a reduction in testing of this age group. Reopening schools are expected to increase the proportion of VOC cases in children relative to the level of VOC community transmission (6, 7).
    - There was insufficient evidence to quantify the effect of VOC transmission in schools compared to transmission in the wider community.
- A single report in the UK estimated that children under ten are about half as likely as adults to transmit the B.1.1.7 variant. Thus, while secondary attack rates from B.1.1.7 cases in children increased 30-50%, the secondary attack rates for VOC child cases were still half that seen in VOC adult cases (3). This finding is similar to the original SARS-CoV-2 variant attack rates.
- Predictive models indicate that the stringency of public health measures other than school closures, particularly with a more transmissible VOC, is the most important determinant of the epidemic trajectory and that schools being open or closed has minimal impact on the epidemic course overall.

## Overview of Evidence

Eight studies pertaining to transmission of VOC B.1.1.7 in children and patterns of transmission in schools were included in this review. The studies reporting transmission in children were mainly observational with the majority being retrospective cohort studies exploring the B.1.1.7 variant transmission in the UK during fall 2020 to early winter 2021. There was also one surveillance data

analysis, one prevalence study and two predictive models. The predictive models were focused on variant transmission and school closures.

A formal risk of bias assessment was not conducted. These observational studies are moderate to high risk of bias due to the retrospective nature of the study design and whether the sample is representative of the population and sufficiently large to obtain generalizable results. The retrospective studies obtained surveillance data in children from large national databases while others focused on small numbers of cases in a specific setting. In addition, due to the nature of the study designs these studies may be at higher risk for missing information bias, selection biases and confounding.

Quantitative predictive models were included. These do not identify actual outcomes of strategies that have been tested, but rather present a range of plausible outcomes within the theoretical scenarios being studied. Their results are useful to compare different options as part of a decision-making process, however the results need to be interpreted with caution as the models will vary on their assumptions, input values based on the epidemic period and region specific parameters used.

A key knowledge gap in this research is the lack of high-quality studies of transmission of VOCs in children and transmission patterns in schools. Although current evidence from a small number of studies on B.1.1.7 reports similar findings, there is the possibility that conclusions could change with further research. There is limited evidence evaluating the severity and clinical course of treatment and further studies that follow these outcomes closely in children are needed. Furthermore, studies of the effects from other VOCs are needed to provide understanding about the role these variants have in transmission of SARS-CoV-2 in children and school settings. Additional evidence is also needed on the clinical epidemiology of VOCs in children. Further research is also needed to investigate whether VOC transmission in schools have a different epidemiology than the original SARS-CoV-2 variant and may need re-evaluation of public health measures in this setting.

## CONTENTS

# COVID-19 CANADIAN SCHOOL OUTBREAKS

A summary of data on the number of school related outbreaks in Canada that included two or more people are summarized in Figure 1. The proportion of outbreaks associated with VOCs increased between January and March 2021. While this data is imperfect, it provides a snapshot of the proportion of school-based outbreaks attributed to VOCs up to the end of March 2021.

The data in Figure 1 is based on webscraping media reports conducted by the Outbreak Response Unit in CIRID and has the following caveats:

- Due to the volume of school outbreaks and the limited information provided about them by some jurisdictions, the database includes only school outbreaks that are referenced in the media, and not those reported by public health in these provinces, for both original strain and VOC-associated outbreaks.
- Unnamed schools are not captured in the webscraping database.
- Therefore, the total number of outbreaks in schools in the webscraping database is likely an underestimate for both original strain and VOC-associated outbreaks.
- The reported date represents the date the outbreak was declared if available, otherwise it represents the earliest date the outbreak was reported in the media.

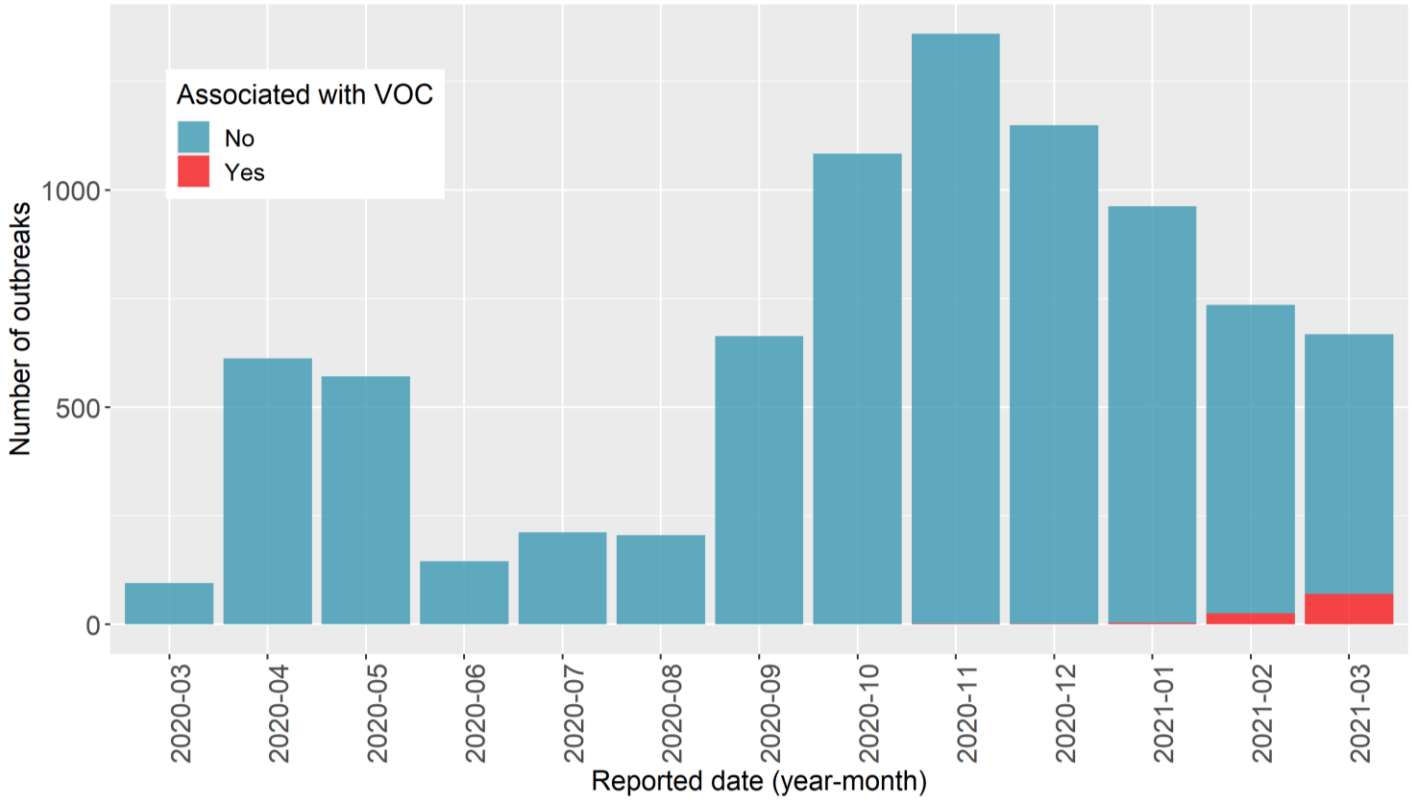


**Figure 1: Outbreaks in Canadian schools reported by the media between March 2020 and March 2021**

# COVID-19 VOC TRANSMISSION IN CHILDREN

The current research has only evaluated the impact of B.1.1.7 on transmission and severity of disease in children in six studies (Table 1). All the studies detail outcomes of B.1.1.7 transmission in children from the UK during November 2020 to January 2021.

- Five studies found that B.1.1.7 does not disproportionately transmit more in children compared to adults (3, 8-11). The increased transmissibility of the variant is observed in both adults and children.
    - Transmission of B.1.1.7 in children correlated strongly with community transmission (5, 9, 10).
    - S-gene target failure (SGTF), which serves as a proxy for B.1.1.7 cases, was studied in adults and children and no difference in SGTF mean excess growth rates between children up to high school (5% (95% CI 1-8%)) and adults (6% (95% CI 4-9%)) were reported (10). This suggested that there are increased VOC infections compared to the original SARS-CoV-2 variant. However, the growth is similar in both children and adults. Furthermore, this study found no evidence that VOC transmission was driven by children (10).
    - A single report in the UK found that children under ten are about half as likely to transmit the B.1.1.7 variant compared to adults >20 years. Although, secondary attack rates from B.1.1.7 cases in children increased 30-50%, the secondary attack rates in VOC child cases were still half that seen in VOC adult case, similar to the original SARS-CoV-2 variant attack rates (3).
    - A modelling study found that data did not support a hypothesis that children were more susceptible to infection from VOCs than the original SARS-CoV-2 variant (11).
- A single study reported that there were increased cases of B.1.1.7 in children <20 years compared to older adults (>70 years old). The authors identified that given the community was in lockdown, but the schools were open, the children had a higher contact rate and risk of being exposed than the older adults (4).
- Two studies evaluated severity of disease in children:
    - One study found no evidence of more severe disease having occurred in children and young people during November 2020 to January 2021 in the UK when the proportion of cases associated with B.1.1.7 was rapidly increasing compared to cases seen in March to May 2020 (8).

- Another study evaluated viral load between children with the variant and those with the original SARS-CoV-2 variant and found no difference, which suggested that infection with the B.1.1.7 VOC does not result in a different clinical course compared to the original strain (10).

**Table 1: Evidence of transmission of variants in children (n=6)**

| STUDY | METHOD | KEY OUTCOMES |
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| **Surveillance Data Analysis (n=2)** | | |
| Mensah 2021 (9)<br><br>Surveillance data analysis<br><br>UK<br><br>Jul – Dec 2020 | Analysis of SARS-CoV-2 infection rates based on Public Health England daily reports during the school year from July to December 2020, including the effect of a national month-long lockdown whilst keeping schools open in November 2020.<br>Three educational settings: preschools (nursery, preschool<5 yr olds), primary schools (reception, age 5-11) and secondary schools (age 11-18) compared to adults (age 16-64) or young adults (age 18-29).<br>Infection rate ratios were used to compare groups. Denominators for each group were taken from the census data. | • Infection rates in adults and children increased rapidly after the week of Nov 23, 2020.<br>• Infection rates in children increased with the cases in the community August through November when the community locked down. In November 2020 schools remained open during lockdown, infection rates in children decreased more slowly than adult cases and the decrease showed a 1 week lag in children. After lockdown, cases in adults started to increase quickly which also coincided with the emergence of B.1.1.7. Cases in secondary school-aged children also increased at a similar rate to adults, whereas those in younger children increased more slowly.<br>• Age specific infection rates were highest in young adults > secondary school children > primary school children > preschool-aged children. The relative rates compared to preschool-aged children were 1.91 (95% CI, 1.74–2.09) primary, 5.17 (95% CI 4.73–5.65) secondary and 10.73 (95% CI, 9.84–11.71) young adults during the week of 19 October 2020. These relative differences continued through the end of 2020 when B.1.1.7 rapidly spread through the UK despite schools being closed at the end of November.<br>• A strong and statistically significant (P<0.001) correlation was observed between weekly SARS-CoV-2 infection rates in adults and the three educational cohorts, with the strongest correlation observed for secondary school-aged children which was seen through to the end of 2020. |

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| Public Health England 2021 (3)<br><br>Surveillance data analysis<br><br>UK<br><br>Sep 2020- Jan 2021 | Surveillance data was analyzed from a total of 6,008 VOC cases and 68246 cases sequenced from 20 September 2020 until 4 January 2021.<br>Contact tracing data 30 November 2020 to 20 December 2020 included 386 805 cases of which 90401/212943 were S-gene target failure (SGTF, a proxy for B.1.1.7) from those with TaqPath data and 3801/ 9321 were B.1.1.7 when sequenced. | • Epidemiologically the age-sex profile was similar between sequenced cases B.1.1.7 (Sept 2020-Jan 2021) and cases identified by SGTF (Dec 2020- Jan 2021) compared to non-B.1.1.7/ non-SGTF cases.<br>• 0-9 year-olds represented 6.1% of B.1.1.7 isolates compared to non-B.1.1.7 at 4.0% among sequenced cases.<br>• Contact tracing data report estimated attack rates are 10-70% higher across age groups. E.g., 0-9 year-olds had a 9.0% secondary attack rate for B.1.1.7 vs. 6.1% for non-B.1.1.7 cases. SGTF attack rates were similarly 30-50% higher, in 0-9 year-olds it was 8.9% for SGTF and 6.2% for non-SGTF. Similar to the originalSARS-CoV-2 variant, children under the age of ten are about half as likely as adults >20 years to transmit the variant to others. |
| **Cohort Studies (n=3)** | | |
| Brookman 2021 (8)<br><br>Retrospective cohort<br><br>UK<br><br>Feb 2021 | Characteristics of children and young people (age <19 years) admitted with acute respiratory COVID-19 between March 1 and May 31, 2020 (n=20) were compared to those admitted Nov 1, 2020, and Jan 19, 2021 (n=60) to King's College Hospital for SARS-CoV-2 infection. | • No difference in demographics e.g., age, sex, ethnicity or deprivation score were identified between waves 1 and 2.<br>• Severe disease necessitating oxygen therapy or ventilatory support was infrequent in both waves and was lower as a proportion of total admission in the second wave than in the first.<br>• These November 2020 to January 2021 data show that many children and young people have been admitted to hospital due to the higher prevalence of SARS-CoV-2 in the hospital's community. The findings in this paper were in line with national data.<br>• There was no evidence of more severe disease having occurred in children and young people since B.1.1.7 increased in circulation, suggesting that infection with the B.1.1.7 variant does not result in a different clinical course to the original strain. |
| Volz 2021 (4) *Preprint*<br>Retrospective cohort<br>UK | This study included an analysis of S-gene target failures (SGTF) a proxy for | • Analysis of trends during lockdown (November 2020) show that non-SGTF cases decreased, but SGTF cases increased across jurisdictions in the UK. |

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| Jan 2021 | B.1.1.7 and non-SGTF cases across England areas between November 8 to December 12, 2020. Age-distributions were assessed. | • After standardizing the cases to the population composition, there are significantly more SGTF cases among individuals aged 0-19 as compared to non-SGTF cases.<br>• The authors suggest differences between the age-distributions of VOC and non-VOC community cases may result from the overall increase in transmissibility of the VOC (especially during a time where lockdown was in force, but schools were open). |
| Walker 2021 (10)<br>*Preprint*<br><br>Retrospective cohort<br><br>UK<br><br>Sep 2020- Jan 2021 | This was a large community surveillance study in the UK. Data were analyzed from nose and throat swabs (n=1,553,687) collected and tested by RT-PCR. S-gene target failures (SGTF) was used as a proxy for B.1.1.7. Cycle threshold (Ct) values (a proxy for viral load), percentage of positives, population positivity and growth rates in SGTF vs non-SGTF positives was assessed by age. | • In the sample 0.98% were positive: 8545 non-SGTF and 3531 SGTF. From early November 2020 to December 31, 2020, the SGTF positives increased e.g., London samples 15% to 38% to 81%.<br>• In November the non-SGTF cases remained stable and the SGTF cases increased adding to the SARS-CoV-2 cases rather than replacing the non-SGTF cases. The growth rate was similar in adults and children.<br>• No association with Ct values (a proxy for viral load) and SGTF cases was identified.<br>• In some regions SGTF cases in younger individuals emerged first, but this was not consistent across regions. No evidence of difference in SGTF growth rates between children up to high school (5% (1-8%)) and adults (6% (4-9%)). This supports B.1.1.7 not being particularly adapted to transmit more in children. |
| **Predictive model (n=1)** | | |
| Davies 2021<br>(11)<br><br>Predictive model<br><br>UK<br><br>Mar 2021 | An age-and regionally-structured mathematical model of SARS-CoV-2 transmission was conducted using Google mobility data and social contact surveys. They used this model to test four different hypotheses to assess which had the best fit. | • The age-and regionally-structured mathematical model found the hypothesis that lower Ct values (an indicator for higher viral load) which supports that VOCs are more transmissible than pre-existing variants fits the model better than the hypothesis that children were more susceptible to infection with the VOC than pre-existing variants. |

# COVID-19 VOC TRANSMISSION PATTERNS IN SCHOOLS

Four studies were identified on COVID-19 transmission patterns in schools, three of which were predictive models (Table 2). Specifically, these studies explored the impact of school closures on transmission. The modelling studies assessed the reproduction number R(t), which indicates the ability of a disease to spread, for different scenarios of closures. R values greater than 1 indicate that cases will increase. These models showed that school closures did have some impact on reducing VOC community incidence, however transmission among school-aged children correlated most strongly with the level of community transmission. These models identified that transmission in schools contributes to but was not driving the spread of VOCs.

- One modelling study found that the reductions in cases and R(t) were largest with continual full national lockdown until April 19, 2021 compared to any of the scenarios with some schools reopened. Reopening primary schools and exam critical years only, or having primary schools open continuously with secondary schools on a two-weeks on-off rotation, will lead to a lower increase in cases and R than if all schools stayed open (6).
- Another modelling study found similar results that strict restrictions in community mobility along with closure of schools will reduce R(t) below 1 (11).
- A UK cohort study found that there was a large rise in school absences in secondary school settings in some regions in London due to the increased cases of the B.1.1.7 variant. This was not observed in primary school settings. There was also a positive correlation between cases in schools and cases in the community. Furthermore, there was no evidence identified that schools were playing a large role in driving the transmission in the community (5).
- A Canadian modelling study estimated that B.1.1.7 would result in a higher likelihood of an outbreak that is 3.6 times and 4.2 times that of an outbreak from original SARS-CoV-2 variant, even with strict control measures in place for adults and children respectively. This increase is predicted irrespective of whether schools are closed or open in scenarios where the community is open due to poor public health interventions and high community transmission risk. The modelling identified that schools do not have a large impact on the trajectory of the epidemic (7).

**Table 2: Evidence of VOC transmission in schools (n=4)**

| STUDY | METHOD | KEY OUTCOMES |
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| **Predictive modelling studies (n=3)** | | |
| Davies 2021 (11)<br><br>Predictive model<br><br>UK<br><br>Mar 2021 | A transmission model fitted to seven NHS regions in England was used to project epidemic changes under different control measures from mid-December 2020 to the end of June 2021. The study is modelled on the assumption of increased transmissibility of the variants.<br><br>Four scenarios were compared: (i) a moderate-stringency scenario; (ii) a high-stringency scenario with schools open; (iii) the same high-stringency scenario, but with schools closed until 15 February 2021; and (iv) a very high-stringency scenario with schools closed. | • The transmission model found that regardless of control measures, all regions were projected to experience a new wave of COVID-19 cases and deaths in early 2021, peaking in February if no substantial control measures were introduced or mid-January if strong control measures were in place.<br>• The model also predicted that more stringent measures (iii and iv) would lead to larger rebound cases when simulated restrictions were lifted in March 2021.<br>• The authors suggest that closing schools along with restrictions in the community can succeed in reducing R below 1. |
| Panovska-Griffiths 2021 (6) *Preprint*<br><br>Predictive model<br><br>UK<br><br>Feb 2021 | The Covasim model, calibrated until January 25, 2021, was used to simulate the impact of a full national lockdown (FNL) with schools closed until April 19, 2021 versus four different partial national lockdown (PNL) scenarios with different elements of schooling open: 1) PNL staggered start 2) PNL full-return 3) PNL with primary and critical exam years (Y11 and Y13) only returning to school and 4) PNL with primary full-time and secondary schools rotating two-weeks in class and two weeks online learning.<br>The study is modelled on the assumption that the new variant is more transmissible, and that the | • The modelling suggests that the reduction in cases and in R is largest with continual FNL until April 19, 2021 compared to any of the scenarios with some schools reopened. Reopening primary schools and exam critical years only, or having primary schools open continuously with secondary schools on a two-weeks on-off rotation, will lead to a lower increase in cases and R than if all schools open.<br>• National lockdown will reduce the number of cases by early March to a similar level as in October with R also falling and remaining below 1.<br>• Across each scenario, the number of new infections is expected to decrease over January and early February lockdowns. |

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| | relative proportion of the new strain increased from September 1, 2020 to January 31, 2021 following a logistic growth function, such that 30% of infections in December and 90% of infections by the end of January 2021 were caused by the new variant. | • Impacts upon deaths are lagged, with plateauing of cumulative deaths seen from February in each scenario. This is due to the vaccine effect having been modelled with a delay of 21 days. Overall, when schools open, we predict a rise in the number of infections and increase in R, and a possible shift in R above 1 once society opens also. |
| Yuan 2021 (7)<br>*Preprint*<br><br>Predictive model<br><br>Toronto<br><br>Jul– Nov 2020 | Using a deterministic age-household-location structured extended SEIR model fitted to demographic data from Toronto, the model is calibrated to epidemiological data between July 31 and November 23, 2020.<br>The model was developed to mimic transmission in households, the community and schools.<br>The new VOC is based on B.1.1.7, assumed to have a 50% increased transmission probability and assumes children will be 70% as susceptible as adults. They also assume it will be the dominant strain after 1 month. The study modelled the impact of the new variant of concern assuming higher susceptibility of children and youth to the new variant. | • Compared to the baseline with the variant strain and the community restricted/ schools closed, which resulted in near epidemic control, the variant strain was estimated to increase the number of cases 3.6x for adults and 4.2x in children and youth.<br>• The scenarios run considering the new variant indicate that schools closing do not have a large impact on the trajectory of the epidemic January to May 2021 as with stage 2 opening (partial opening) of the community the prediction was 7x or 7.5x more cases with schools closed vs. open.<br>• Exponential increases in cases were predicted regardless of whether schools were open or closed in scenarios where the community is fully opened (stage 3) due to weak public health interventions and high community transmission risk. |
| **Cohort studies (n=1)** | | |
| Southhall 2021 (5)<br>*Preprint*<br><br>Retrospective cohort<br><br>UK | Analysis of absenteeism of pupils and teachers was conducted to assess the impact of the new variant, B.1.1.7.<br>Specific regions were evaluated to assess the differential impact of the new variant. London and Kent were chosen due to the high number of new variant compatible cases reported, while Devon and the West Midlands were chosen due to having | • A large rise in the number of absences per school in secondary school settings was observed in the South East and Greater London in December but not in other regions or primary school settings.<br>• Authors suspect absences were related to increased transmissibility of the new B.1.1.7 variant which contributed to the rise of cases in secondary schools in these regions. |

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| Sep-Dec 2020 | had fewer reported cases compatible with the new variant. Additionally, on the 3rd December 2020, Devon was in tier 2 and the West Midlands was in tier 3. | • A positive correlation was found between cases in the community and cases in schools in most regions.<br>• No significant evidence to suggest that schools are playing a significant role in driving transmission in the community.<br>• Careful monitoring may be required as schools re-open to determine the effect associated with opening schools upon community incidence.<br>• In London, Kent and the West Midlands, a weak correlation between cases in secondary school pupils and community cases that increases with lag time, indicating that an increase in community cases is most positively correlated with an increase in school cases in pupils at a later date.<br>• The same result was observed for primary school pupils in Kent and the West Midlands. However, a negligible correlation between community cases and cases in primary school children in London across all time lags was observed. |

## Methods:

A daily scan of the literature (published and pre-published) is conducted by the Emerging Science Group, PHAC. The scan has compiled COVID-19 literature since the beginning of the outbreak and is updated daily. Searches to retrieve relevant COVID-19 literature are conducted in Pubmed, Scopus, BioRxiv, MedRxiv, ArXiv, SSRN, Research Square and cross-referenced with the COVID-19 information centers run by Lancet, BMJ, Elsevier, Nature and Wiley. The daily summary and full scan results are maintained in a refworks database and an excel list that can be searched. Targeted keyword searching was conducted within these databases to identify relevant citations on COVID-19 and SARS-COV-2. Search terms used included:
SCHOOL TRANSMISSION TERMS: (B.1.1.7 or 501Y.V1 or B.1351 or 501Y.V2 or P1 or P2 or B1.1.1.28 or B.1.1.33 or 501Y.V3 or B.1.426 or variant) AND school AND transmission
CHILDREN TERMS: B.1.1.7 or 501Y.V1 or 202012/01 or B.1351 or 501Y.V2 or P1 or P2 or B1.1.1.28 or B.1.1.33 or 501Y.v3 B.1.426 or variant) AND (children or adolescent)
This review contains research published up to March 26, 2021.
Each potentially relevant reference was examined to confirm it had relevant data and relevant data was extracted into the review.

Grey Literature

A grey literature search was conducted to compliment the database search. The grey literature focused on key websites that reports on B.1.1.7 variants, including Public Health England and SPOR Evidence Alliance. The original grey literature search was conducted on March 24-March 26, 2021.

Peer-review

This document underwent peer-review by a subject matter expert, and editorial and science to policy review by the Office of the Chief Science Officer.

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