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SARS-CoV-2 infection and transmission in educational settings: a prospective, cross-sectional analysis of infection clusters and outbreaks in England

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Summary

Background Understanding severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and transmission in educational settings is crucial for ensuring the safety of staff and children during the COVID-19 pandemic. We estimated the rate of SARS-CoV-2 infection and outbreaks among staff and students in educational settings during the summer half-term (June–July, 2020) in England.

Methods In this prospective, cross-sectional analysis, Public Health England initiated enhanced national surveillance in educational settings in England that had reopened after the first national lockdown, from June 1 to July 17, 2020. Educational settings were categorised as early years settings (<5-year-olds), primary schools (5–11-year-olds; only years 1 and 6 allowed to return), secondary schools (11–18-year-olds; only years 10 and 12), or mixed-age settings (spanning a combination of the above). Further education colleges were excluded. Data were recorded in HPZone, an online national database for events that require public health management. RT-PCR-confirmed SARS-CoV-2 event rates and case rates were calculated for staff and students, and direction of transmission was inferred on the basis of symptom onset and testing dates. Events were classified as single cases, coprimary cases (at least two confirmed cases within 48 h, typically within the same household), and outbreaks (at least two epidemiologically linked cases, with sequential cases diagnosed within 14 days in the same educational setting). All events were followed up for 28 days after educational settings closed for the summer holidays. Negative binomial regression was used to correlate educational setting events with regional population, population density, and community incidence.

Findings A median of 38 000 early years settings (IQR 35 500–41 500), 15 600 primary schools (13 450–17 300), and 4000 secondary schools (3700–4200) were open each day, with a median daily attendance of 928 000 (752 000–1085 000) students. There were 113 single cases of SARS-CoV-2 infection, nine coprimary cases, and 55 outbreaks. The risk of an outbreak increased by 72% (95% CI 28–130) for every five cases per 100 000 population. Staff had higher incidence than students (27 cases [95% CI 23–32] per 100 000 per day among staff compared with 18 cases [14–24] in early years students, 6·0 cases [4·3–8·2] in primary schools students, and 5·1 cases [4·0–6·5] in secondary schools students), and most cases linked to outbreaks were in staff members (154 [73%] staff vs 56 [27%] children of 210 total cases). Probable direction of transmission was staff to students in 26 outbreaks, staff to student in eight outbreaks, student to staff in 16 outbreaks, and student to student in five outbreaks. The median number of secondary cases in outbreaks was one (IQR 1–2) for student index cases and one (1–5) for staff index cases.

Interpretation SARS-CoV-2 infections and outbreaks were uncommon in educational settings during the summer half-term in England. The strong association with regional COVID-19 incidence emphasises the importance of controlling community transmission to protect educational settings. Interventions should focus on reducing transmission in and among staff.

Funding Public Health England.

Introduction

The COVID-19 pandemic has caused many countries to impose strict lockdown measures, including school closures, to reduce the spread of the virus. Educational settings that have remained open during the pandemic have enforced substantial constraints on activities.13 School closures can, however, have adverse consequences on children’s educational needs and social and mental wellbeing.2 Additionally, children from disadvantaged backgrounds are more likely to suffer from school closures, including access to free school meals and social services.3 This is particularly important in the context of young children having a significantly lower incidence of COVID-19 compared with adults and developing mainly mild illness that is rarely fatal.4

In England, the first imported COVID-19 cases were identified in late January, 2020, and increased rapidly from early March before plateauing in mid-April and
Research in context

Evidence before this study
We searched PubMed for articles published between Jan 1 and Aug 31, 2020, with the terms “COVID-19” or “SARS-CoV-2” with “school”, “education”, “nursery”, or “student” to identify publications relating to COVID-19 cases and outbreaks in educational settings globally, with no language restrictions. Most publications were reviews and opinion pieces on the impact of school closures on disease transmission and child health. There were very few reports of COVID-19 outbreaks in educational settings, mainly involving a single school with a small number of staff and students affected. Secondary schools (ie, adolescents aged 11–18 years) appear to experience wider transmission and larger outbreaks than schools for younger students.

Added value of this study
We analysed data on confirmed COVID-19 cases and outbreaks in educational settings in England following the reopening of mainly early years settings and primary schools as the first national lockdown was eased. The number of events (cases, coprimary cases, and outbreaks) reported in this period was low, with an estimated 1·1 events (95% CI 0·75–1·4) per 1000 settings per month in early years settings, 6·5 events (5·3–7·9) per 1000 settings per month in primary schools, and 4·5 (2·7–7·1) events per 1000 settings per month in secondary schools, although the proportion of case introductions that resulted in outbreaks ranged from 26% (95% CI 18–36) to 40% (25–57) depending on the setting. The number of outbreaks in educational settings was strongly associated with regional COVID-19 incidence, with the risk of an outbreak increasing by 72% (28–130) for every five cases per 100,000 increase in community incidence (p<0·0001). Staff members were more likely to be affected than students.

Implications of all the available evidence
Taken together with literature evidence, our findings emphasise a need to improve awareness and infection control measures for staff members both within and outside the educational setting. The strong correlation between COVID-19 outbreaks and regional incidence and the proportion of cases in school settings ultimately resulting in outbreaks also highlight the importance of controlling the disease in the community to protect staff and students in educational settings.

Methods

Study design
This was a prospective, cross-sectional surveillance, taking advantage of the comprehensive, national reporting system that exists in England. Institutions are required to inform their local PHE Health Protection Team (HPT) when they suspect or identify a case or outbreak of COVID-19. HPTs then do a risk assessment for each event and decide on any additional investigations and infection control measures required, based on factors such as the number of cases, illness severity, and potential transmission across so-called bubbles. HPTs document all events on HPZone, an online national database for recording events that require public health management.

PHE held daily national meetings to discuss situations of interest across England, including educational settings. A risk assessment was done and a decision for extensive testing made on a case-by-case basis, with particular focus on situations where wider transmission might have occurred.

PHE has legal permission, provided by Regulation 3 of The Health Service (Control of Patient Information) Regulations 2002, to process patient confidential information for national surveillance of communicable diseases and as such, individual patient consent is not required.

Definitions
Educational settings that reopened during the summer half-term (June 1–July 17, 2020) included nurseries and preschools, reception, primary school years 1 and 6, secondary school years 10 and 12, and children of any age whose parents were key workers. The included educational settings and children were categorised as follows: early years settings (nurseries and preschools for children aged <5 years), primary schools (ages 4–11 years; reception includes 4–5-year-olds, and school years 1 and 6 include 5–6-year-olds and 10–11-year-olds, respectively), secondary schools (ages 11–18 years; school years 10 and 12 include 14–15-year-olds and 16–17-year-olds, respectively), and settings for mixed age groups (combining primary and secondary school-aged children) or those with special educational needs or disabilities (SEND). Further education colleges were excluded as they included students older than 18 years. A small number of educational settings then declining. As part of the first national lockdown, schools were closed from March 20, 2020, with wider lockdown measures announced on March 23. Gradual easing of lockdown began on May 10 and, from June 1, included re-opening of some early years settings and primary and secondary school years following implementation of strict infection control measures, including smaller classes separated into distinct social bubbles that do not mix with other bubbles in the setting, physical distancing, and frequent handwashing.

Public Health England (PHE) has been monitoring and managing COVID-19 outbreaks across all settings throughout the pandemic in England. Here, we summarise the frequency of suspected and confirmed cases and outbreaks among students and staff in educational settings during the summer half-term (from early June to mid-July), focusing particularly on the index case, potential source of infection, secondary cases, and public health measures implemented to control the spread of the virus.
in geographical areas of high prevalence remained closed and school attendance was not mandatory.

Individuals with confirmed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection (SARS-CoV-2 RT-PCR positive on an upper respiratory tract sample) were included in this analysis if they had physically attended their educational setting during their infectious period, which was defined as from 48 h before symptom onset to 10 days after symptom onset.10 Coprimary cases were defined as at least two confirmed cases within 48 h, typically in the same household (eg, siblings testing positive because their key-worker parent had confirmed SARS-CoV-2 infection). An outbreak was defined as at least two epidemiologically linked cases, where sequential cases were diagnosed within 14 days in the same educational setting (corresponding to the maximum incubation period after exposure to infection).11 An outbreak was deemed to be over when no further cases were reported 28 days from the last confirmed case. A bubble was defined as a group of staff and children who performed all activities together and did not interact with other bubbles.7 The aim was to isolate individual bubbles if any member of the bubble developed COVID-19, asking members to self-isolate for 14 days while allowing the remaining bubbles to continue to attend the educational setting.

Data management and analysis

All potential events in educational settings reported in HPZone during the summer half-term were followed up for 28 days after the educational settings closed for the summer holidays. Missing information in HPZone was obtained from the local HPT or educational setting as required. For outbreaks, direction of transmission from the index case to secondary cases was inferred on the basis of the date of symptom onset for symptomatic individuals. We evaluated associations between event measures in educational settings, regional COVID-19 incidence, and other regional characteristics to identify possible predictors for cases and outbreaks. We calculated regional COVID-19 incidence using national SARS-CoV-2 RT-PCR data collated by PHE for COVID-19 surveillance,3 and regional population estimates from the Office for National Statistics.12 Pillar 1 (health and care workers, or those in a hospital setting who were seriously ill) and pillar 2 (wider community, including home testing, drive-through, and regional test centres) SARS-CoV-2 RT-PCR results were used to estimate regional incidence.13 Negative binomial regression was used to correlate outbreaks with regional population, population density, and community COVID-19 incidence, producing rate ratios.

SARS-CoV-2 event rates and case rates were calculated for staff and children attending an educational setting, irrespective of whether the infection was acquired within or outside the educational setting. For event rate calculations, attendance denominators for open educational settings were obtained from Department for Education reports.14 Event rates were calculated independently for early years settings, primary schools, and secondary schools (including SEND settings), but excluded a small number of settings for mixed age groups for which denominators were unavailable. For case rate calculations, denominators were drawn from Department for Education attendance figures,14 based on daily school registers. Coprimary cases were counted as separate cases. Staff attendance was only available for primary and secondary schools and did not distinguish between student-facing or other staff, so aggregated case rates across primary and secondary school settings were calculated. Student attendance figures did not include a small proportion of children of key workers or vulnerable children15 who attended school but were not part of the year groups returning to school in June, 2020; calculated rates therefore excluded cases in this category. Cases in settings for mixed age groups were also not included in estimating case rates for staff or children. Statistical analyses were done in STATA (version 16.1).

Role of the funding source

This surveillance was internally funded by PHE and did not receive any specific grant funding from agencies in the public, commercial, or not-for-profit sectors.

### Table 1: SARS-CoV-2 infection rates for single cases, coprimary cases, and outbreak events in educational settings in England, June 1–July 17, 2020

| Number of settings open per day | Number of confirmed events | Confirmed event rate per 1000 settings per month (95% CI) |
|---------------------------------|-----------------------------|--------------------------------------------------------|
|                                 | Minimum (IQR)               | Single case | Coprimary cases | Outbreak | Single case* | Coprimary cases | Outbreak | Total |
| Early years                     | 28 000 (35 500–41 400)      | 21          | 3              | 16       | 0·63        | 0·079          | 0·42     | 1·1   |
|                                 | 43 000                      | 6           | 4              | 13       | 0·40–0·94   | 0·016–0·23    | 0·24–0·68 | 0·75–1·4 |
| Primary                         | 6900 (13 450–17 300)        | 69          | 6              | 27       | 4·8         | 0·38          | 1·7      | 6·5   |
|                                 | 18 100                      | 6           | 6              | 24       | 3·8–6·0     | 1·4–1·6       | 1·2–2·5  | 5·3–7·9 |
| Secondary                       | 2900 (37 000–42 000)        | 11          | 0              | 7        | 2·7         | 1·8           | 4·5      | 2·7–7·1 |
|                                 | 4400                        | 10          | 0              | 7        | 1·4–4·9     | 0·70–3·6      |          |       |

Events rates are given to two significant figures and are reported for all early years, primary, and secondary school settings, including those for students with special educational needs or disabilities, but not for settings for mixed age groups spanning multiple primary and secondary years. SARS-CoV-2=severe acute respiratory syndrome coronavirus 2.1 Includes coprimary events.

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authors had access to the data; the first and final authors (SAI and SNL) verified the data and had final responsibility for the decision to submit for publication.

**Results**

In England, educational settings re-opened on June 1, 2020, starting with nurseries and preschools, reception, and year 1 and year 6 students, and extending to years 10 and 12 in secondary schools from June 15, 2020 (appendix p 2). A median of 38,000 early years settings (IQR 35,500–41,500), 15,600 primary schools (13,450–17,300), and 4000 secondary schools (3700–4200) were open each day during this period (table 1). Median attendance in the above year groups was 928,000 students (630,000–1230,000; appendix pp 3, 5, 6).

Between June 1 and Aug 2, 2020 (weeks 23–31 of 2020), there were 45,778 laboratory-confirmed COVID-19 cases...
in England, 5038 (11%) of whom were aged 0–18 years. In this age group, the national COVID-19 case rate rose from 3·8 cases per 100 000 population in week 23 to 5·6 cases per 100 000 population in week 31, with most of the increase occurring after June (figure 1).

PHC received 327 reports of COVID-19 related events in educational settings in England during the summer half-term; 12 (4%) were excluded because of duplicated reports, educational setting type, or did not meet the attendance definition (ie, cases attending during their infectious period; figure 2). In 138 (44%) of the remaining 315 events, SARS-CoV-2 infection was excluded following local public health investigations. The remaining 177 events involved 113 (64%) single confirmed cases, nine (5%) coprimary cases, and 55 (31%) confirmed outbreaks, with a total of 130 confirmed cases in children and 213 in staff (figure 2; appendix p 7). Single cases were most prevalent in the east of England and London, and outbreaks in the Yorkshire and Humber region (appendix p 8). The outbreaks were small (median two cases [IQR 2–5]), with 29 (53%) outbreaks involving only one secondary case. When the index case was a child, the maximum number of secondary cases was six (median one case [1–2]) compared with 12 secondary cases (median one case [1–5]) when the index case was a staff member (appendix p 9). Larger outbreaks were predominantly in early years settings and primary schools as expected, considering these settings had a greater proportion of their usual attendees returning to school. For every case introduction into an educational setting (ie, single cases, coprimary cases, and outbreak index cases), the risk of an outbreak occurring was 40% (95% CI 25–57; 16 of 40 events) in early years settings, 26% (18–36; 27 of 102 events) in primary schools, and 39% (17–64; seven of 18 events) in secondary schools.

There was a strong association between outbreaks and regional COVID-19 incidence, with the risk of an outbreak increasing by 72% (95% CI 28–130) for every five cases per 100 000 population increase in community incidence, but no association was seen between outbreaks and regional population size or population density (figure 3). However, single cases including coprimary cases and index cases in outbreaks were significantly associated with regional population density, with a 19% (0·4–42) increase in cases every 1000 people per km² increase in regional population density (figure 3).

Rates of SARS-CoV-2 infection and outbreaks were very low across all educational settings, with the highest risk in primary schools (table 1). Staff had higher rates of individual SARS-CoV-2 infection and outbreaks than students, albeit with wide 95% CIs (table 2). Among children, the rate of individual infections was highest in early years settings, which were also more likely to be linked to outbreaks (table 2).

The 113 single cases included 55 (49%) children and 58 (51%) staff, and occurred mainly in primary schools (69 [61%] cases; appendix p 7). Three staff were hospitalised with COVID-19, two of whom required intensive care admission for respiratory support, and the third died of COVID-19 after probably acquiring the infection from a household member with confirmed COVID-19 who had acquired the infection in the community. None of the children were hospitalised for COVID-19. Among 77 (68%) single cases with available information, further action was not taken for five cases and no additional cases were identified. In the remaining 72 instances, the case and their contact bubble were excluded from school for 14 days, including seven settings that decided to close entirely (with the duration of closure variable by setting) because of a perceived high risk of onward transmission, although this was contrary to national recommendations.
There were nine coprimary cases including 19 children and one staff (a parent). Seven coprimary cases included siblings in the same household, where they most likely co-acquired the infection from a parent. The siblings in six coprimary cases were in different primary schools (five involving two siblings and one involving three siblings). Two coprimary cases were in early years settings (one with two siblings from the same household, and another with three children across two households with no contact links between the households). The final coprimary case involved a parent and child at the same school who most likely acquired the infection from another household member. Ten children in five households were asymptomatic and had been tested because they were household contacts of a symptomatic index case who tested positive for SARS-CoV-2. In all but two coprimary cases, a parent or family member was the index; in the remaining two, the infection source could not be identified. Public health management included exclusion of the contact bubbles from the educational setting and no additional cases were identified in these excluded contact bubbles or the remaining bubbles that continued to attend school.

Figure 3: Associations between number of outbreaks and regional COVID-19 incidence (A), regional population (C) and population density (E), and equivalent plots for single confirmed cases (B, D, F)

Trend lines are given only where significant results were obtained from negative binomial regression: for the number of confirmed outbreaks in educational settings versus COVID-19 regional incidence (panel A); and for the number of confirmed cases versus regional population density (panel F). RRs are given to two significant figures. RR=rate ratio.
period), 16 in early years settings (0.04% of the median 38,000 early years settings open), seven in secondary schools (0.17% of the median 4000 secondary schools open), and five in schools for mixed age groups (table 1; figure 4). These outbreaks involved a total of 154 cases among staff and 56 among children (appendix p 7). All affected contact bubbles were excluded from school and 17 (31%) schools also decided to close on an interim basis (for deep cleaning or for exclusion periods to elapse) or for the rest of the term.

The 27 primary school outbreaks were mostly small (median one secondary case [IQR 1–4]). 13 (48%) outbreaks involved staff only (affecting 48 members), including eight where only two staff members were affected, one of which was a SEND setting (figure 4). In four of the remaining five staff outbreaks, the source was not identified but the outbreak was propagated through contact between administrative and teaching staff in school. 12 other outbreaks involved staff and children, including ten where a child was most likely the index case, seven of whom were diagnosed as part of household contact-tracing because their parent tested positive for SARS-CoV-2. The other two of the 12 outbreaks involved potential staff-to-child transmission including one where two staff members (who were partners) at the same school tested positive for SARS-CoV-2 after becoming symptomatic. Mass testing was undertaken because of the large number of potential school contacts and ten (14%) of 74 additional staff and three (3%) of 93 children tested positive for SARS-CoV-2 (appendix p 10).

The final two primary school outbreaks each involved possible transmission between two children, although no clear contact between the children within the educational setting could be established; separate acquisition at home or in the community could, therefore, not be ruled out.

Outbreaks in early years settings were also small (median one secondary case [IQR 1–3]; figure 4). A staff member was the index case in ten (63%) outbreaks, and five outbreaks involved staff members only, including one where 12 of 16 staff tested positive following community exposures linked to a religious festival. Mass swabbing in one outbreak identified nine (24%) of 38 children, four (33%) of 12 staff, and ten (9%) of 112 household contacts of staff and children as SARS-CoV-2 positive (appendix p 10).

Seven outbreaks occurred in secondary schools, three involving staff only (figure 4). Most outbreaks were small (median one secondary case [IQR 1–1]). In one outbreak, possible transmission occurred between two children in the same bubble but from different households who also mixed together socially outside school. The single largest outbreak occurred in a SEND school with eight cases among staff members and one child. Several cases were identified following wider swabbing (appendix p 10).

The remaining five outbreaks occurred in settings for mixed age groups catering to students with SEND, and involved staff only, with 24 confirmed cases in total (figure 4). Wider swabbing done in two schools because of the perceived vulnerability of the students identified seven (3%) of 202 additional staff members with SARS-CoV-2 and no cases among the 16 children (appendix p 10).

The source of infection was not systematically reported for single cases, while all coprimary cases acquired the infection at home. For outbreaks, the probable transmission direction from the index case was staff to staff in 26 outbreaks, staff to student in eight outbreaks, student to staff in 16 outbreaks, and student to student in five outbreaks. Overall, the potential source of infection was identified in 45 (80%) of 56 students involved in an outbreak and included a household contact (11 [24%] cases), a school staff member (21 [47%] cases), or another
The potential source of infection was identified in 127 (82%) of 154 staff cases linked to outbreaks and included another staff member (91 [72%] cases) or a child (21 [17%] cases) in the educational setting. In the remaining 15 cases, it was a household contact (11 [9%]) or a community contact (four [3%] cases).

The index case was a staff member in 34 (62%) of 55 outbreaks and a child in the remaining 21 (38%).

Discussion

Active, prospective, and systematic national surveillance identified a low overall risk of SARS-CoV-2 infection. The index case was a staff member in 14 (62%) of 23 outbreaks, and included another staff member or a child in all cases. The remaining 11 outbreaks involved a household contact (eight [73%] cases) or a community contact (three [27%] cases).
among staff and students in educational settings when schools re-opened after the first national lockdown in England, with the risk of a seeding event resulting in an outbreak ranging from 26% to 40% depending on the setting type. Primary schools had the highest event rates of SARS-CoV-2 infection and the highest outbreak rates, which probably reflect the greater number of children and staff returning to these settings during the summer half-term. Infection and outbreak rates were higher in staff than children and staff-to-staff transmission was most common, while student-to-student transmission was rare. We found a strong correlation between COVID-19 outbreaks in educational settings and regional COVID-19 incidence, while the risk of single infections was associated with regional population size and density.

England took a cautious approach for opening schools after the lockdown, when community COVID-19 incidence was low across most regions. Extensive social distancing and infection control measures were implemented with strict limitations on the number of staff and children in each bubble. The low rates of SARS-CoV-2 infection and outbreaks in England are consistent with other countries that opened their educational settings after lockdown and those that kept their schools open throughout the pandemic, all with varying background incidence. There are very few reports of widespread SARS-CoV-2 infection in early years settings and primary schools, especially when compared with other institutions such as hospitals, care homes, and prisons, and other workplace settings. We did, however, find a significant correlation between outbreaks in educational settings and community COVID-19 incidence, even during a period of low community incidence. This finding is not surprising since increased community transmission provides more opportunities for virus introduction into educational settings.

The potential for spread within educational settings, as observed from wider swabbing of some schools in our surveillance and from reports from other countries, especially in secondary schools, highlights the importance of maintaining high vigilance and acting quickly when cases or outbreaks are identified. Early exclusion of cases, including those identified through contact tracing of household contacts of confirmed cases, is crucial for reducing the risk of onward transmission in educational settings, as data from educational settings in Australia also show.

The higher risk of SARS-CoV-2 infection among staff emphasises a need to strengthen infection control measures at two levels. Staff members need to be more vigilant for exposure outside of educational settings to protect themselves, their families, and the educational setting; within education premises, stringent infection control measures between staff need to be reinforced, including limiting use of common staff rooms and cross-covering staff across bubbles.

By contrast, children mainly acquired SARS-CoV-2 infection at home and most were asymptomatic. Reassuringly, we found very little transmission between students, which is consistent with emerging literature for young children. Even among coprimary cases, the siblings did not seed the infection into their individual bubbles. Reassuringly, too, there were very few transmission events between staff and children, especially given the difficulties in maintaining physical distancing with younger children and those attending SEND schools.

The strength of this study is the public health infrastructure that allows real-time reporting, risk assessment, and management of situations nationally. The large number of reports of suspected situations highlight the strong historical engagement between educational settings and HPTs. Daily assessment of situations allowed a pragmatic approach to risk assessment and the need for additional investigations and infection control measures.

There are, however, important limitations when considering the generalisability of our findings. Educational settings opened when COVID-19 incidence was low, and only in regions with low community transmission. These educational settings implemented stringent infection control measures with strict protocols for bubble sizes, which might not be achievable in fully opened school settings. Only 1·6 of 8·9 million students nationally attended school and it is likely that some populations, such as children of key workers, were over-represented. Additionally, there were very few secondary school years open during the summer half-term. Our results, therefore, cannot be generalised to secondary schools, especially since the risk of infection, disease, and transmission is likely to be higher in older than younger children.

There are also limitations associated with upper respiratory tract swabbing to confirm SARS-CoV-2 infection in terms of the timing of the test in relation to symptoms, the person doing the test, and sensitivity of RT-PCR assays. Recent serological investigations in care homes have highlighted the extent to which swabbing might underestimate the extent of an outbreak in institutional settings. Moreover, only a few educational settings were selected for wider testing, yet the identification of additional cases suggests that the extent of some outbreaks might have been underestimated. Finally, whole genome sequencing could help to determine whether the outbreaks were caused by a single strain or due to multiple separate introductions and, therefore, not due to transmission within the educational setting.

In conclusion, the re-opening of schools during the summer half-term was associated with very few cases or outbreaks in England, albeit with smaller classes in selected school years and proportionally greater attendance in early years settings and primary schools. Infections and outbreaks were more likely to involve staff members than students. The proportion of seeding events resulting in outbreaks in schools, and the strong
correlation between COVID-19 outbreaks and regional incidence, both highlight the importance of controlling the disease in the community to protect educational settings.

Contributors
SAI and SNL contributed to the study conceptualisation and methodology; formal analysis; investigation; data curation; writing of the original draft; writing, review, and editing of the manuscript; and figures. VS, JLB, and MER contributed to the study conceptualisation, methodology, and supervision and writing, review, and editing of the manuscript.

Declaration of interests
We declare no competing interests.

Data sharing
Applications for relevant anonymised data should be submitted to the PHE Office for Data Release.

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