

**Title: COVID-19-related school closures, United States, July 27, 2020 – June 30, 2022**

**Authors:** Nicole Zviedrite<sup>1</sup>, MPH, Ferdous Jahan, MD, MPH, Sarah Moreland<sup>2</sup>, MPH, Faruque Ahmed, PhD, MPH, Amra Uzicanin, MD, MPH

<sup>1</sup> Corresponding author.

<sup>2</sup> Current affiliate: Henry M. Jackson Foundation, Bethesda, Maryland, USA.

**Author affiliations:** Centers for Disease Control and Prevention, Atlanta, Georgia, USA (N. Zviedrite, F. Jahan, S. Moreland (former affiliate), F. Ahmed, A. Uzicanin); Cherokee Nation Operational Solutions, LLC, Tulsa, Oklahoma, USA (F. Jahan); Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee, USA (S. Moreland (former affiliate)); Henry M. Jackson Foundation, Bethesda, Maryland, USA (S. Moreland (current affiliate)).

**Corresponding author:** Nicole Zviedrite, MPH, Centers for Disease Control and Prevention, 1600 Clifton Rd NE, MS V18-2, Atlanta, Georgia, USA, 30333, [jmu6@cdc.gov](mailto:jmu6@cdc.gov), 404-639-3961

**Article summary line:** COVID-19-related school closures occurred annually in the US and their temporal patterns mirror the general patterns of COVID-19 activity at the national level as observed through routine COVID-19 epidemiological surveillance.

**Running title:** COVID-19–related school closures: USA, July 2020 - June 2022

**Keywords:** school closures, COVID-19, nonpharmaceutical interventions, community mitigation

## Abstract

As part of a multi-year project that monitored illness-related school closures, we conducted systematic daily online searches from July 27, 2020–June 30, 2022, to identify public announcements of COVID-19-related school closures (COVID-SCs) in the US lasting  $\geq 1$  day. We explored the temporospatial patterns of COVID-SCs and analyzed associations between COVID-SCs and national COVID-19 surveillance data. COVID-SCs reflected national surveillance data: correlation was highest between COVID-SCs and both new PCR test positivity (correlation coefficient,  $r = 0.73$ , CI: 0.56, 0.84) and new cases ( $r = 0.72$ , CI: 0.54, 0.83) in school year (SY) 2020-21, and with hospitalization rates among all ages ( $r_s = 0.81$ , CI: [0.67, 0.89]) in SY 2021-22. The number of reactive COVID-SCs during SYs 2020-21 and 2021-22 greatly exceeded previously observed numbers of illness-related reactive school closures in the US, notably being nearly 5-fold greater than reactive closures observed during the 2009 H1N1 Pandemic (H1N1pdm09 virus).

## Introduction

While unplanned school closures occur every year, outside of a pandemic only a small minority (~1%) are associated with infectious disease while the majority are due to weather and natural disasters (1). However, the initial months (February-June 2020) of the coronavirus disease 2019 (COVID-19) pandemic in the United States (US) led to unprecedented, nearly-simultaneous, nationwide implementation of kindergarten through twelfth grade (K-12) school closures throughout the US, as a part of a wider effort to slow virus transmission and reduce disease burden (2). In most communities, these early pandemic-related closures were implemented pre-emptively as a non-pharmaceutical intervention before community transmission was high. In contrast, the subsequent COVID-19-related school closures occurring in the 2020–21 and 2021–22 school years (SYs) were predominantly reactive, i.e., occurring after infection had affected students and/or staff.

As school re-convened for SYs 2020–21 and 2021–22, schools and districts were faced with the challenge of providing in-person education and services during the ongoing pandemic. In a previous analysis, we described the transition to online learning that occurred between February-June 2020, following the COVID-19 related preemptive closures of schools and school districts (2). The subsequent two pandemic-affected school years (2020-21 and 2021-22) were characterized by the deployment of various education modalities, including education that was fully in-person, fully distance learning, or a hybrid model (3, 4, 5). In both years, among schools offering in-person learning (fully or hybrid), school closures continued to be implemented in response to local transmission dynamics and policies, as well as due to other consequences of the

pandemic (vaccination of staff and students and side effects of vaccination, teacher and staff shortages, and pandemic related mental health issues).

This study describes trends in reactive COVID-19-related K-12 school closures (COVID-SCs) during the COVID-19 pandemic in the US from July 27, 2020, to June 30, 2022 and analyzes associations between COVID-SCs and national level COVID-19 epidemiological surveillance data.

## **Methods**

### **Data collection**

We conducted daily systematic online searches from July 27, 2020 through June 30, 2022, to identify public announcements of unplanned, illness-related K-12 school closures in the United States. Searches were conducted in Google and Google News using the following terms: "school closed" and either "COVID," "COVID-19," or "coronavirus." Additionally, the search string "(academy OR school OR district OR class) AND (close OR closing OR closure OR cancel OR cancelled) AND (coronavirus OR corona OR 'COVID-19' OR COVID OR 'novel coronavirus')" was employed in a Google Alert. Publicly available COVID-19-related school closure dashboards identified during these routine searches were also checked, including those published online by school districts, state and local education authorities, and private entities. All school closure announcements were saved as portable document files (PDFs) prior to data abstraction. Only announcements mentioning COVID-19 as a reason for closure were included for analysis. Additional details on the search strategy and data abstraction processes are available in previously published methodology (1, 2). Data were not collected from July 1 – July 25, 2021

as this coincided with school summer break in the US. Fully in-person and hybrid learning modalities were classified as open, and modalities without in-person learning (i.e., fully distanced learning and closed) were classified as closed. Unplanned closure was defined as a transition from being open to being closed for in-person instruction, for  $\geq 1$  day. If a school/district reopened for  $\geq 1$  day and then closed again, the subsequent closure was counted as a new occurrence of closure. For closures that spanned both unplanned and planned closure days, such as those contiguous with weekends or planned holidays, only unplanned closure days were counted. For closures for which a reopening date could not be identified following closure, length of closure was assumed to be one day. Schools that delayed in-person learning at the start of the school year, through closure or full distance-learning, were not captured in this data collection. For each identified COVID-SC, we abstracted school or school district name, state, dates of closure and reopening, as well as reasons for closure as reported in the announcements.

## **Contextualizing school closures**

To better understand the characteristics of schools and districts experiencing COVID-SCs, each closure event was matched to publicly available data downloaded from the National Center for Education Statistics (NCES) using the respective NCES district or school ID (identified using district/school name and location) (6, 7). Some districts and schools experienced multiple COVID-SC events during the study period and, therefore, appear more than once in the resulting dataset. For each public school and public school district, COVID-SC data were matched with the respective year (2020-21, 2021-22) of NCES data, and for private schools, COVID-SCs were matched with the most recent year of data available (2019-2020) in NCES. NCES data include information such as the number of schools per district, the number of students and staff, the number of students eligible in the federal free or reduced-price school

lunch programs (only for public schools and public school districts), urbanicity, and grade span data. We excluded: schools with pre-kindergarten or transitional kindergarten students only; school districts with no schools; schools with no students; vocational, special education, and alternative schools with missing values for student enrollment; and permanent distance-learning-only or adult education schools.

## **Epidemiologic data**

We gathered publicly available COVID-19 surveillance data from July 27, 2020 – June 30, 2022, including daily new cases and death counts (8), weekly hospitalization rates (9), and daily PCR positivity (10) for the duration of the study period. Hospitalization rates were reported per epidemiological week and corresponding weekly averages were calculated for new cases, deaths, and PCR positivity at the national level. Epidemiological weeks run Sunday – Saturday, with epidemiological week one being the first week to hold four or more days from the new calendar year.

## **Data analysis**

We described characteristics of school closures according to the data abstracted from public announcements. Specific reasons for COVID-SCs were summarized by grouping them into 12 non-mutually exclusive categories under two primary themes (1) transmission-related reasons (COVID-19 cases, suspected cases, increased student absenteeism, increased staff absenteeism, cluster or widespread transmission in the community, state or local guidance/mandate to close schools in response to COVID-19, to clean/disinfect school facilities, and other reasons related to COVID-19 mitigation including testing, contact tracing, quarantine of students and staff, prevention of holiday-related surge, death of staff member, critical lack of

community resources – including contact tracers, and noncompliance with Governor’s executive orders) and (2) non-transmission-related reasons (COVID-19 vaccinations, teacher/staff shortages, for student/staff mental health, and other reasons associated with COVID-19 including staff protests of in-person learning, protests over mask policies, transportation issues specific to COVID-19, lack of resources specific to COVID-19, and in order to work on the COVID-19 mitigation plan).

We compared weekly patterns of COVID-SCs and with COVID-19 epidemiological surveillance data at the national level (new cases and deaths, hospitalization rates, and lab test positivity). We calculated Spearman rank correlations ( $r$ ) and 95% confidence intervals (CI) to evaluate these relationships (at  $\alpha=0.05$ ) during the school years. The final week of each calendar year was excluded from analysis, as this week coincides with school winter break in the US. P-value calculation for the Spearman’s rank correlation was based on Fisher’s Z-transformation. Analysis was conducted using SAS 9.4 (SAS Institute Inc., Cary, North Carolina). Visualizations were created using Microsoft Excel and Microsoft Power BI. Results for each school year are presented sequentially.

Additional analyses, including calculations of in-person school days lost, the frequency and patterns of repeat closures of schools for COVID-19, the cumulative incidence of COVID-SCs by states, and bivariate and multivariable regression analyses, are described in supplementary material.

## **Results**

### **School Year 2020–2021**

From July 27, 2020, to June 30, 2021, an estimated 19,273 COVID-SCs (Table 1) were experienced by 16,890 unique schools. About three-quarters closed as part of district-wide closures. More than 11 million students were affected, losing more than a combined 159 million in-person student-days. The majority of COVID-SCs were observed in the first half of the school year (Aug – Dec 2020) and they peaked in epidemiological week 47, the week prior to the US Thanksgiving holiday (Fig 1). The median number of in-person schools days lost per closure nationally was 10 days (interquartile range (IQR): 3-23) (Fig S1), however it reached to over 20 days in seven states (California, Colorado, Illinois, Indiana, Kentucky, Minnesota, and Nevada) (Fig S2). Most schools experiencing COVID-SCs, experienced only one COVID-SC during the school year (Table S1). However, 12.1% (n= 2,036) experienced between two and seven COVID-SCs during the school year, with two being the most common (n=1,756, 86.2%).

Among the announcements reporting reasons for closure, the most common reason was having positive cases in the school, followed by clusters or widespread transmission in the community (Table 2). Additionally, state and local mandates to close schools in response to COVID-19 accounted for more than 20% of closures. Mandates were issued either as part of an ongoing policy triggered by reaching a covid threshold, such as the positivity rate of testing (11), and second, in response to local surges in cases (12, 13). While few COVID-SCs were attributed to non-transmission related reasons such as vaccination of staff and students or non-specific teacher shortages attributed to the pandemic, nearly 30% of COVID-SCs between epidemiological weeks 6 and 11 of 2021 were due to vaccination of staff and side effects of vaccination (Fig 1).

Transmission-related COVID-SCs were strongly correlated with weekly COVID-19 testing positivity rates ( $r=0.73$ , CI: 0.56, 0.84) and with new COVID-19 cases ( $r=0.72$ , CI: 0.54,



0.83) (Table 3). Transmission-related COVID-SCs were moderately correlated with both new COVID-19 deaths by week ( $r=0.51$ , CI: 0.25, 0.69) and weekly laboratory confirmed COVID-19-associated hospitalization rates for all ages ( $r=0.64$ , CI: 0.42, 0.78) (Table 4). Age-specific correlation with hospitalization rates varied, with the 5-17 years age group, which aligns with the K-12 student population, having the weakest correlation ( $r=0.37$ , CI: 0.09, 0.60) and correlations strengthening for each subsequent older age group (Table 4). The peak in weekly COVID-SCs preceded the peaks in COVID-19 disease surveillance indicators (new cases, deaths, and percent positive PCR tests) by roughly 6-8 weeks (Fig 2.a, Fig 3.a).

## **School Year 2021–2022**

From August 1, 2021, to June 30, 2022, more than 14.6 million students were affected by an estimated 25,907 COVID-SCs (Table 1). Among unique schools which experienced COVID-SCs, the majority closed once (77.5%), while more than 20% closed 2-8 times (Table S1). Most closures occurred in the first three weeks of 2022, peaking at epidemiological week 2 (Fig 1). The median number of in-person school days lost per closure was 2 days (IQR: 1-4) (Fig S1).

Closures occurred in all 50 states and DC, with >1,000 closures in each of seven states (Texas, Illinois, Missouri, Ohio, North Carolina, Georgia, and Tennessee) (Fig S3.a) accounting for more than a third of all COVID-SCs observed during the school year. More than half of the schools in Alabama, Nevada, and Oregon (51.6%, 51.3, and 51.2%, respectively) and between 40% and 50% of schools in eight additional states (Oklahoma, Maryland, Tennessee, Utah, Kentucky, Colorado, Virginia, and Nebraska; Fig S3.b) experienced a COVID-SC.

Most district and school level COVID-SCs were attributed to positive cases in the schools (58.5% and 61.5%, respectively) (Table 2). Non-transmission-related reasons accounted

for a greater number of COVID-SCs than in the prior school year, particularly those due to long-term teacher/staff shortages (shortages related to hiring and retention challenges, rather than directly linked to current disease transmission).

Transmission-related COVID-SCs were strongly correlated with weekly hospitalization rates for all ages ( $r=0.81$ , CI: 0.67, 0.89), among which correlation was moderate for the 5-17 year old age group ( $r=0.69$ , CI: 0.47, 0.82) and strong for the three adult aged groups (Table 4). Transmission-related COVID-SCs were moderately correlated with new COVID-19 cases ( $r=0.61$ , CI: 0.38, 0.76) and new COVID-19 deaths ( $r=0.58$  CI: 0.35, 0.74), while there was no significant correlation for percent positive COVID-19 PCR tests (Table 3). The peak in weekly COVID-SCs occurred within 1-2 weeks of the peaks in weekly new COVID-19 cases, percent PCR positivity, and hospitalization rates, and preceded the peak in weekly new COVID-19 deaths by 3 weeks (Fig 2.b, Fig 3.b).

## Discussion

Our study describes COVID-19 school closures as school systems and communities grappled with ongoing disease transmission during a rapidly evolving pandemic. The COVID-SCs we analyzed reflect the SARS-CoV-2 spread among school-aged children and staff, as demonstrated by the correlation between COVID-SCs and COVID-19 epidemiologic surveillance. The large increase in illness-related closures during SYs 2020-21 and 2021-22, which was nearly 5-fold higher than those observed during severe influenza seasons, including the 2009 H1N1 Pandemic (H1N1pdm09 virus) (14) and subsequent moderate and severe influenza seasons (namely 2017-18, 2018-19, and 2019-20), was nearly fully attributed to COVID-19 (15). This increase likely reflected both ongoing transmission of SARS-CoV-2 and

the greater clinical severity of COVID-19 infection among children as compared to influenza, as demonstrated by both higher rates of hospitalization and higher rates of ICU admission among those 18 and younger (16, 17).

The most frequently documented reason for closure in both SYs was COVID-19 cases in the school or school district. School year 2020-21 also had a significant number of closures due to increased community transmission and due to state/local mandates to close schools in response to COVID-19, consistent with the changing incidence of COVID-19 among both the general population and children over the study period (8, 9). COVID-SCs due to teacher absenteeism (due to illness of themselves or others) and teacher/staff shortages were more common in SY 2021-22 than in SY 2020-21. While teacher shortages were also reported prior to the pandemic, they were exacerbated by pandemic (18, 19).

In SY 2020-21, the number of schools open to in-person education varied throughout the semester with some schools teaching in-person, some relying solely on distance learning, some utilizing hybrid or mixed methods, and others moving between different modalities in response to disease transmission and related guidance throughout the school year (5). COVID-19 transmission during the 2020-21 SY was primarily dominated by the ancestral strain of SARS-CoV2, which would only later be supplanted by new variants as the predominating virus in circulation (20, 21). The majority of COVID-SCs in SY 2020-21 occurred in the first semester (August – December 2020), with the bulk occurring in the two weeks leading up to the Thanksgiving holiday (November 26, 2020) break. Despite recommendations from the CDC against travel during the holiday (22), travel during Thanksgiving week of 2020 (November 22-28, 2020) was at its highest since the start of the pandemic eight months prior (23, 24). During this time of increased social gatherings and movement, many schools that closed prior to

Thanksgiving chose to stay shuttered until after the subsequent winter break (25, 26, 27). Annual (by school year) peaks among the epidemiological surveillance data occurred in January 2021. Following Emergency Use Authorization (EUA) by the Food and Drug Administration (FDA) of the first COVID-19 vaccine in December 2020 (28), teachers and staff became eligible for vaccination as part of the essential workforce on March 2, 2021 and all those 16 years of age or older on April 19, 2021 (29). Subsequently, the succeeding Alpha variant began to predominate in early April 2021 (21, 30), holding that position until June as the number of COVID-SCs slowed and remained comparably low.

Thereafter, the Delta variant, characterized by being both more transmissible and more severe than both the ancestral strain or Alpha variant (31, 32), predominated through the start of SY 2021-22 until mid-December (21). During this period, FDA EUAs for COVID-19 vaccines were extended to those 12-15 years of age in May 2021 and finally to those 5-11 years of age in October 2021 (30), whereby all K-12 students, teachers, and staff were eligible for vaccination during the first half of SY 2021-22. Prior to the start of SY 2021-22, it was reported that almost 90% of teachers were vaccinated nationally (33). Expanded vaccine eligibility and high uptake among teachers and staff coincided with a return to in-person learning for nearly all schools in the US in SY 2021-22 (3, 5). In this SY, epidemiologic data peaks in January 2022 amid the domination of the Omicron variant, thus far characterized as the fastest spreading variant (34), were matched with the highest weekly counts of COVID-SCs. While we observed lower correlation of COVID-SCs with COVID-19 cases and percent PCR positivity in 2021-22 than in the previous year, correlations with new deaths and hospitalization rates were both higher. Strong correlation between COVID-SCs and hospitalization rates may suggest that COVID-SCs

are not only associated with disease prevalence but also with the severity of the dominant circulating variant.

Various prevention measures were implemented in schools and districts to prevent the spread of SARS-CoV-2 (35), thereby, notionally reducing the number of COVID-SCs. However, disparities in their prevalence of implementation have been observed across locales and school poverty levels (35). Infection prevention measures include non-pharmaceutical interventions that can be rapidly implemented in schools, such as masking, social distancing, and quarantining, all of which have previously been shown to be effective at slowing influenza transmission in community congregate settings (36); at least one study documented that use of face masks reduces SARS-CoV-2 infection incidence in k-12 schools (37).

This study is subject to at least four limitations. First, reports are limited to publicly available data, and some closures may have been missed depending on how they were reported. Second, data may be incomplete for various reasons including, delays in identifying public announcements of school closures, incomplete or unavailable public announcements, or lags in data entry. Third, lengths of closure may be unknown when the specific date of reopening cannot be ascertained or because the school/district remains closed. And fourth, learning modality may not be specified in the data abstraction source (the announcement and/or website), and the data may therefore not capture all transitions from in-person to distance learning. However, these data were collected without burden to schools or districts and were readily available in near-real-time. These limitations likely lead to underestimation of the number and duration of school closures. Therefore, our results likely convey the lower range of the impact of COVID-SCs during this time period.

The COVID-SC data presented here were collected as part of an ongoing research project implemented to document how school closures occur outside of an influenza pandemic (1). In the absence of a true surveillance system, these were the best data available on COVID-SCs from the very early days of the pandemic. This project documented near-simultaneous nationwide closures implemented as a mitigation strategy during the spring of 2020 (2) as well as an unprecedented number of illness-related reactive school closures during the two subsequent school years, 2020-21 and 2021-22. These data could be used in conjunction with epidemiologic surveillance and other data for future computer simulations to explore the impact of the COVID-19 pandemic at various geographic levels and to help evaluate effectiveness of contemporaneous pandemic interventions. With SARS-CoV-2 /COVID-19 already established as an endemic disease and with the re-established circulation of other respiratory pathogens, local outbreaks of COVID-19, influenza, and other diseases will likely continue to occur, and some will cause reactive school closures. The continued monitoring of disease-related school closures should preserve the ability to detect their occurrence in near real-time as a component of community-based surveillance during pandemics and severe outbreaks. Additionally, ongoing surveillance for disease-related school closures would help understand their underlying causes, scale and distribution, and facilitate evaluation of their impact on schools and communities.

## **Disclaimer**

The opinions expressed by authors contributing to this journal do not necessarily reflect the opinions of the Centers for Disease Control and Prevention or the institutions with which the authors are affiliated.

## **Acknowledgments**

The authors would like to thank the data collection team, including our unit ORISE Fellows (Livvy Shafer, Pallavi Malla, and Larry Ayer) and contractors (Tamara Cummings, Jasminn Evans, Atea Francis, Elisha Gilbert, Esther Amoakohene, and Zaneta Oliver).

## **Funding**

This work was supported by the US Centers for Disease Control and Prevention (CDC). The co-authors are or were employees of the CDC (NZ FA AU), contractors (FJ) of the US CDC, or ORISE Fellows (SM) at the time of the study. Ferdous Jahan (FJ) is employed by Cherokee Nation Operational Solutions, LLC. The funder (Cherokee Nation Operational Solutions, LLC) provided support in the form of salary for the author (FJ), but did not have any additional role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript. During the study period, SM was a fellow appointed through the Research Participation Program at the Centers for Disease Control and Prevention administered by the Oak Ridge Institute for Science and Education through an interagency agreement between the US Department of Energy and the US Centers for Disease Control and Prevention.

## References

1. Wong KK, Shi J, Gao H, Zheteyeva YA, Lane K, Copeland D, et al. Why is school closed today? Unplanned K-12 school closures in the United States, 2011-2013. *PLoS One*. 2014;9(12):e113755.
2. Zviedrite N, Hodis JD, Jahan F, Gao H, Uzicanin A. COVID-19-associated school closures and related efforts to sustain education and subsidized meal programs, United States, February 18-June 30, 2020. *PLoS One*. 2021;16(9):e0248925.
3. Parks SE, Zviedrite N, Budzyn SE, Panaggio MJ, Raible E, Papazian M, et al. COVID-19-Related School Closures and Learning Modality Changes - United States, August 1-September 17, 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(39):1374-6.
4. MCH Strategic Data. COVID-19 IMPACT: School District Operational Status, Updates for Spring 2021 2021 [Available from: <https://www.mchdata.com/covid19/schoolclosings>].
5. Burbio's K-12 School Opening Tracker 2022 [Available from: <https://about.burbio.com/school-opening-tracker>].
6. National Center for Education Statistics. Common Core of Data. 2011-2019. [Available from: <http://nces.ed.gov/ccd/schoolsearch/>].
7. National Center for Education Statistics. Private School Universe Survey. 2011-2018. [Available from: <https://nces.ed.gov/surveys/pss/>].
8. Centers for Disease Control and Prevention, COVID-19 Response. COVID-19 Case Surveillance Public Data Access, Summary, and Limitations. [Available from: <https://data.cdc.gov/Case-Surveillance/United-States-COVID-19-Cases-and-Deaths-by-State-o/9mfq-cb36>].
9. COVID-NET: COVID-19-Associated Hospitalization Surveillance Network, Centers for Disease Control and Prevention. [Available from: [https://gis.cdc.gov/grasp/covidnet/covid19\\_5.html](https://gis.cdc.gov/grasp/covidnet/covid19_5.html). Accessed on March 7, 2023].
10. U.S. Department of Health & Human Services, HealthData.gov Team. COVID-19 Diagnostic Laboratory Testing (PCR Testing) Time Series. [Available from: <https://beta.healthdata.gov/dataset/COVID-19-Diagnostic-Laboratory-Testing-PCR-Testing/j8mb-icvb>].
11. Shapiro E. New York City to Close Public Schools Again as Virus Cases Rise: The New York Times; 2020 [updated Aug 19, 2021. Available from: <https://www.nytimes.com/2020/11/18/nyregion/nyc-schools-covid.html>].
12. Beshear A. [https://governor.ky.gov/attachments/20201118\\_Executive-Order\\_2020-969\\_State-of-Emergency.pdf](https://governor.ky.gov/attachments/20201118_Executive-Order_2020-969_State-of-Emergency.pdf). In: Governor, editor. 2020.
13. Gordon R. Emergency Order under MCL 333.2253 – Gatherings and Face Mask Order: Michigan Department of Health and Human Services; 2020 [updated Nov 15, 2020. Available from: <https://www.michigan.gov/coronavirus/resources/orders-and-directives/lists/executive-directives-content/gatherings-and-face-mask-order-4>].
14. Kann L, Kinchen S, Modzelski B, Sullivan M, Carr D, Zaza S, et al. ILI-related school dismissal monitoring system: an overview and assessment. *Disaster medicine and public health preparedness*. 2012;6(2):104-12.
15. Zviedrite N, Jahan FA, Zheteyeva YA, Gao H, Uzicanin A. School Closures due to Seasonal Influenza: Experience from Eleven Influenza Seasons – United States, 2011–2022. medRxiv. 2023:2023.08.28.23294732 [Preprint]. <https://doi.org/10.1101/2023.08.28>.



16. Delahoy MJ, Ujamaa D, Taylor CA, Cummings C, Anglin O, Holstein R, et al. Comparison of Influenza and Coronavirus Disease 2019-Associated Hospitalizations Among Children Younger Than 18 Years Old in the United States: FluSurv-NET (October-April 2017-2021) and COVID-NET (October 2020-September 2021). *Clin Infect Dis*. 2023;76(3):e450-e9.
17. Shein SL, Carroll CL, Remy KE, Rogerson CM, McCluskey CK, Lin A, et al. Epidemiology and Outcomes of SARS-CoV-2 Infection or Multisystem Inflammatory Syndrome in Children vs Influenza Among Critically Ill Children. *JAMA Netw Open*. 2022;5(6):e2217217.
18. J. S, K. d. The pandemic has exacerbated a long-standing national shortage of teachers: Economic Policy Institute; 2022 [updated Dec 6, 2022. Available from: <https://www.epi.org/publication/shortage-of-teachers/>.
19. National Center for Education Statistics. U.S. Schools Report Increased Teacher Vacancies Due to COVID-19 Pandemic, New NCES Data Show 2022 [updated Mar 3, 2022. Available from: [https://nces.ed.gov/whatsnew/press\\_releases/3\\_3\\_2022.asp](https://nces.ed.gov/whatsnew/press_releases/3_3_2022.asp).
20. Centers for Disease Control and Prevention. COVID Data Tracker. Atlanta, GA: US Department of Health and Human Services, CDC; 2023, March 21. <https://covid.cdc.gov/covid-data-tracker> [
21. Hodcroft EB. 2021. "CoVariants: SARS-CoV-2 Mutations and Variants of Interest." <https://covariants.org/> [
22. Fox M. CDC recommends against travel for Thanksgiving. CNN, November 19, 2020. [Available from: <https://www.cnn.com/2020/11/19/health/cdc-thanksgiving-travel-wellness-bn/index.html>.
23. Bureau of Transportation Statistics. Thanksgiving week travel: total number of trips down, long distance trips up over last year 2020 [Available from: <https://www.bts.gov/data-spotlight/thanksgiving-travel-long-distance-trips-are-up>.
24. Perrone M, Renault M. Heading into holidays, US COVID-19 testing strained again. AP News. 2020.
25. Mangrum M. All Metro Nashville Public Schools students to stay remote after Thanksgiving [Available from: <https://www.tennessean.com/story/news/education/2020/11/23/mnps-schools-stay-closed-after-thanksgiving-coronavirus-spike/6342873002/>.
26. Kelley JP. Dayton schools to hold no classes for next 6 weeks, go to school in June instead. Dayton Daily News. 2020 Mar 2, 2023.
27. Sawchuk S, Gewertz C. Schools Are Retreating to Remote Learning as COVID-19 Surges. Do They Have To? 2020 [Available from: <https://www.edweek.org/leadership/schools-are-retreating-to-remote-learning-as-covid-19-surges-do-they-have-to/2020/11>.
28. FDA Approves First COVID-19 Vaccine - Approval Signifies Key Achievement for Public Health [press release]. U.S. Food and Drug Administration Aug 23, 2021 2021.
29. U.S. Department of Health & Human Services. Coronavirus: COVID-19 Vaccines 2022 [updated Dec 12, 2022. Available from: <https://www.hhs.gov/coronavirus/covid-19-vaccines/index.html>.
30. Centers for Disease Control and Prevention, David J. Sencer CDC Museum. CDC Museum COVID-19 Timeline [Available from: <https://www.cdc.gov/museum/timeline/covid19.html>.
31. Earnest R, Uddin R, Matluk N, Renzette N, Turbett SE, Siddle KJ, et al. Comparative transmissibility of SARS-CoV-2 variants Delta and Alpha in New England, USA. *Cell Rep Med*. 2022;3(4):100583.

32. Twohig KA, Nyberg T, Zaidi A, Thelwall S, Sinnathamby MA, Aliabadi S, et al. Hospital admission and emergency care attendance risk for SARS-CoV-2 delta (B.1.617.2) compared with alpha (B.1.1.7) variants of concern: a cohort study. *Lancet Infect Dis.* 2022;22(1):35-42.
33. The White House. FACT SHEET: President Biden to Announce New Actions to Get More Americans Vaccinated and Slow the Spread of the Delta Variant [press release]. Jul 29, 2021 2021.
34. Liu Y, Rocklöv J. The effective reproductive number of the Omicron variant of SARS-CoV-2 is several times relative to Delta. *J Travel Med.* 2022;29(3).
35. Pampati S, Raspberry CN, Timpe Z, McConnell L, Moore S, Spencer P, et al. Disparities in Implementing COVID-19 Prevention Strategies in Public Schools, United States, 2021-22 School Year. *Emerg Infect Dis.* 2023;29(5):937-44.
36. Qualls N, Levitt A, Kanade N, Wright-Jegede N, Dopson S, Biggerstaff M, et al. Community Mitigation Guidelines to Prevent Pandemic Influenza - United States, 2017. *MMWR Recommendations and reports : Morbidity and mortality weekly report Recommendations and reports.* 2017;66(1):1-34.
37. Donovan CV, Rose C, Lewis KN, et al. SARS-CoV-2 Incidence in K–12 School Districts with Mask-Required Versus Mask-Optional Policies — Arkansas, August–October 2021. *MMWR Morb Mortal Wkly Rep* 2022;71:384–389. DOI: <http://dx.doi.org/10.15585/mmwr.mm7110e1>external icon

## Tables

**Table 1. Characteristics of COVID-19-associated school closures by school year\* – United States, July 27, 2020 – June 30, 2022.**

Characteristics of COVID-19-associated school closures	Total	School year	
		2020-2021	2021-2022
Number of school closure events <sup>†</sup> , n (column %)	10,884	6,322 (58.1)	4,562 (41.9)
District-wide	3,443 (31.6)	1,528 (24.2)	1,915 (42.0)
Individual school	7,441 (68.4)	4,794 (75.8)	2,647 (58.0)
Total estimated number of unique schools closed	36,761	16,890 (45.9)	19,871 (54.1)
Total estimated number of closed schools <sup>†§</sup> , n (column %)	45,180	19,273 (42.7)	25,907 (57.3)
By closure type			
District-wide	37,739 (83.5)	14,479 (75.1)	23,260 (89.8)
Individual school	7,441 (16.5)	4,794 (24.9)	2,647 (10.2)
By school type, n (column %)			
Public	44,463 (98.4)	18,620 (96.6)	25,843 (99.8)
Private	717 (1.6)	653 (3.4)	64 (0.3)
By school grade level <sup>§</sup> , n (column %)			
Elementary school (K-5 grade)	18,273 (40.4)	7,701 (40.0)	10,572 (40.8)
Elementary-middle school (K-8 grade)	8,241 (18.2)	3,037 (15.8)	5,204 (20.1)
Elementary-high school (K-12 grade)	1,107 (2.5)	461 (2.4)	646 (2.5)
Middle school (6-8 grade)	6,405 (14.2)	2,751 (14.3)	3,654 (14.1)
Middle-high school (6-12 grade)	2,137 (4.7)	969 (5.0)	1,168 (4.5)
High school (9-12 grade)	8,587 (19.0)	4,048 (21.0)	4,539 (17.5)
Not specified	430 (1.0)	306 (1.6)	124 (0.5)
By season, n (column %)			
Fall (Sept- Nov)	18,298 (40.5)	11,660 (60.5)	6,638 (25.6)
Winter (Dec-Feb)	22,651 (50.1)	5,694 (29.5)	16,957 (65.5)
Spring (Mar-May)	2,818 (6.2)	1,642 (8.5)	1,176 (4.5)
Summer (Jun-Aug)	1,413 (3.1)	277 (1.4)	1,136 (4.4)
By urbanicity, n (column %)			
City	17,689 (39.2)	6,734 (34.9)	10,955 (42.3)
Suburban	13,609 (30.1)	6,116 (31.7)	7,493 (28.9)
Town	4,429 (9.8)	1,959 (10.2)	2,470 (9.5)
Rural	9,098 (20.1)	4,181 (21.7)	4,917 (19.9)
Not specified	355 (0.8)	283 (1.5)	72 (0.3)
By HHS region <sup>¶</sup> , n (column %)			
HHS 1	1,906 (4.2)	1,301 (6.8)	605 (2.3)
HHS 2	4,556 (10.1)	3,146 (16.3)	1,410 (5.4)
HHS 3	5,642 (12.5)	2,886 (15.0)	2,756 (10.6)
HHS 4	9,399 (20.8)	3,978 (20.6)	5,421 (20.9)
HHS 5	9,646 (21.4)	3,627 (18.8)	6,019 (23.1)
HHS 6	5,103 (11.3)	1,050 (5.5)	4,053 (15.6)
HHS 7	2,217 (4.9)	588 (3.1)	1,634 (6.3)
HHS 8	2,493 (5.5)	872 (4.5)	1,621 (6.3)
HHS 9	2,334 (5.2)	1,453 (7.5)	881 (3.4)
HHS 10	1,879 (4.2)	372 (1.9)	1,507 (5.8)
Number of students affected <sup>¶§</sup> , n (row %)	25,837,466	1,123,2072	14,605,394
Number of teachers affected <sup>†§</sup> , n (row %)	1,710,459	752,264	958,195
Percent of students eligible for free/reduced-price lunch <sup>††§</sup> , median (IQR)	57.2 (33.2 – 83.2)	52.0 (28.8 – 79.1)	60.9 (37.0 – 85.7)
Number of in-person student-days lost <sup>†††</sup> , (row %)	205,689,158	159,968,778	45,720,380
Number of unplanned closure days <sup>¶¶</sup> , median (IQR)	4 (1-10)	10 (3-23)	2 (1-4)

\*School year: 2020-2021 (July 27, 2020 to June 30, 2021), 2021-2022 (Aug 1, 2021 to Jun 30, 2022).

†School closures were defined as a transition from being opened to being closed for in-person instruction excluding any scheduled days off; fully in-person and hybrid learning modalities were classified as open, and fully remote and closed were classified as

closed. Closure events were documented at either the district-level or the individual school level, based on the source and scope of the closure decision as reported in the announcements.

<sup>‡</sup>Schools were counted once for each time they were part of a school closure event at either the district-level or school level.

<sup>§</sup>Number of schools closed in district-wide closures, total number of students, total number of teachers, number of students eligible for federal free/reduced lunch, and number of schools by urbanicity and grade levels were estimated by matching the public school district ID or public school ID with the district/school data with the respective year as obtained from the National Center for Education Statistics (NCES) and private school ID with the 2019/20 private school data as obtained from the Private School Universe Survey (PSS) respectively. Due to missing information on urbanicity in 2021/22 NCES public school data, the information on urbanicity for the 2021/22 SY public school closures was obtained from the 2020/21 NCES public school data<sup>6,7</sup>. School NCES ID wasn't found for 168 schools (124 for 2020-2021 school year and 44 for 2021-2022 school year), and were categorized as public or private by manual search based on the location of schools in the school closure announcements.

<sup>¶</sup>Regions of the United States Department of Health & Human Services (HHS). <https://www.hhs.gov/about/agencies/regional-offices/index.html>.

<sup>#</sup>Students were counted once for each school closure event. The number of students was missing for 562 schools (Public -325, Private- 237).

<sup>\*\*</sup>Teachers were counted once for each school closure event. Part-time teaching positions were reported as a fraction of one full-time position. The number of teachers was missing for 1,041 schools (Public - 804, Private – 237).

<sup>††</sup>Data only for public schools.

<sup>‡‡</sup>In-person student-days lost estimated by multiplying the number of students per school by the number of unplanned closure days.

<sup>¶¶</sup>2,075 schools did not have reopening dates and defaulted to 1-day closure, among them 1,996 (96%) were during the 2020-2021 school year.

**Table 2. Reasons\* for COVID-19 Related K-12 School Closure events– United States, July 27, 2020—June 30, 2022<sup>†</sup>**

Reasons for school closure decision stated in announcement of COVID-19-related closure events <sup>‡</sup>	Total		2020-2021		2021-2022	
	District	School	District	School	District	School
Number of COVID-19 related closure events	3,443	7,441	1,528	4,794	1,915	2,647

School closure announcement mentions only COVID-19	85 (2.5)	123 (1.7)	43 (2.8)	76 (1.6)	42 (2.2)	49 (1.9)
School closure announcement mentions COVID-19 and specific reasons	3,358 (97.5)	7,318(98.3)	1,485 (97.2)	4,718 (98.4)	1,873 (97.8)	2,598 (98.1)
Transmission-related reasons						
Due to positive case(s)	1,845 (53.6)	4,511 (60.6)	724 (47.4)	2,829 (59.0)	1,121 (58.5)	1,682 (61.5)
In student(s)	758 (22.0)	1,412 (19.0)	233 (15.2)	651 (13.6)	525 (27.4)	761 (28.7)
In staff member(s)	763 (22.2)	1,359 (18.3)	226 (14.8)	575 (12.0)	537 (28.0)	784 (29.6)
In household member of student/staff	15 (0.4)	24 (0.3)	11 (0.7)	12 (0.3)	4 (0.2)	12 (0.5)
In visitor(s)	2 (0.1)	0 (0.0)	2 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)
Due to suspected case(s)	78 (2.3)	224 (3.0)	64 (4.2)	173 (3.6)	14 (0.7)	51 (1.9)
In student(s)	23 (0.7)	70 (0.9)	21 (1.4)	48 (1.0)	2 (0.1)	22 (0.8)
In staff member(s)	33 (1.0)	71 (1.0)	27 (1.8)	53 (1.1)	6 (0.3)	18 (0.7)
In household member of student/staff	0 (0.0)	5 (0.1)	0 (0.0)	5 (0.1)	0 (0.0)	0 (0.0)
Due to increased student absenteeism	515 (15.0)	732 (9.8)	56 (3.7)	132 (2.8)	459 (24.0)	600 (31.3)
Due to increased staff absenteeism	1,022 (29.7)	1,955 (26.3)	183 (12.0)	536 (11.2)	839 (43.8)	1,419 (53.6)
Due to cluster or widespread transmission in the community	1,096 (31.8)	1,918 (25.8)	727 (47.8)	1,556 (32.5)	369 (19.3)	362 (13.7)
Due to state or local guidance/mandate	348 (10.1)	1,146 (15.4)	318 (20.8)	1,091 (22.8)	30 (1.6)	55 (2.1)
To clean/disinfect classrooms, buildings, and facilities	240 (7.0)	682 (9.2)	102 (6.7)	562 (11.7)	138 (7.2)	120 (4.5)
Other <sup>§</sup>	356 (10.3)	750 (10.1)	146 (9.6)	532 (11.1)	210 (11.0)	218 (8.2)
Non-transmission-related reasons						
Vaccination of staff/students	83 (2.4)	56 (0.8)	66 (4.3)	49 (1.0)	17 (0.9)	7 (0.3)
Side effects of vaccination	9 (0.3)	18 (0.2)	9 (0.6)	18 (0.4)	0 (0.0)	0 (0.0)
Teacher shortage	135 (3.9)	158 (2.1)	20 (1.3)	26 (0.5)	115 (6.0)	132 (5.0)
Mental health	158 (4.6)	48 (0.6)	0 (0.0)	0 (0.0)	158 (8.3)	48 (1.8)
Other <sup>†</sup>	17 (0.5)	32 (0.4)	0 (0.0)	10 (0.2)	17 (0.9)	22(0.8)

<sup>‡</sup>Reasons are recorded as stated in the school closure announcements.

<sup>†</sup>School year: 2020-2021 (July 27, 2020 to June 30, 2021), 2021-2022 (Aug 1, 2021 to Jun 30, 2022).

<sup>‡</sup>Categories are not mutually exclusive because a closure announcement may attribute the closure to more than one factor and/or there may be more than one announcement that contributes the closure to different factors.

<sup>§</sup>Other reasons include contact tracing, quarantine of students and staff, prevention of holiday-related surge, precautionary measure as a concern of community spread due to union wanting work stoppage, death of staff member, unable to find substitute teachers, transportation issues, critical lack of community resources – including contact tracers, testing, out of an abundance of caution, and flu/other respiratory and/or enteric virus-related illnesses, internet outage, facility issues, and noncompliance with Governor's executive orders.

<sup>†</sup>Other reasons include staff protesting in-person learning, protest over mask policy, transportation issue, lack of resources, allowing time for testing, and work on the COVID-19 mitigation plan.

**Table 3. Weekly correlation between COVID-related school closures (SC)\* and COVID-related cases, deaths, and PCR positivity by school year<sup>†</sup>— United States, July 27, 2020— June 30, 2022**

	Weeks Considered as the Winter School Break <sup>‡</sup>					
	Week 53/52		(Weeks 52 & 53)/(51 & 52)		(Weeks 53 & 1)/(52 & 1)	
Transmission-related SCs <sup>§</sup>						
	R (95% CI)	P	R (95% CI)	P	R (95% CI)	P
<b>COVID Cases<sup>#</sup></b>						
2020 – 2021	0.721 (0.544, 0.832)	<0.001	0.728 (0.552, 0.837)	<0.001	0.707 (0.521, 0.824)	<0.001
2021 – 2022	0.609 (0.384, 0.760)	<0.001	0.591 (0.358, 0.750)	<0.001	0.583 (0.346, 0.744)	<0.001
<b>COVID Deaths<sup>#</sup></b>						
2020 – 2021	0.507 (0.255, 0.688)	<0.001	0.510 (0.256, 0.692)	<0.001	0.482 (0.221, 0.673)	<0.001
2021 – 2022	0.580 (0.346, 0.741)	<0.001	0.592 (0.359, 0.750)	<0.001	0.571 (0.331, 0.736)	<0.001
<b>PCR Positivity<sup>**</sup></b>						
2020 – 2021	0.734 (0.563, 0.840)	<0.001	0.748 (0.581, 0.850)	<0.001	0.720 (0.540, 0.832)	<0.001
2021 – 2022	0.280 (-0.011, 0.523)	0.056	0.245 (-0.052, 0.497)	0.102	0.232 (-0.065, 0.487)	0.122
Total SCs <sup>¶</sup>						
<b>COVID Cases<sup>#</sup></b>						
2020 – 2021	0.772 (0.620, 0.864)	<0.001	0.790 (0.645, 0.876)	<0.001	0.761 (0.601, 0.858)	<0.001
2021 – 2022	0.511 (0.257, 0.693)	<0.001	0.486 (0.223, 0.678)	<0.001	0.478 (0.213, 0.672)	0.001
<b>COVID Deaths<sup>#</sup></b>						
2020 – 2021	0.577 (0.345, 0.737)	<0.001	0.589 (0.358, 0.747)	<0.001	0.557 (0.316, 0.725)	<0.001
2021 – 2022	0.596 (0.367, 0.751)	<0.001	0.610 (0.382, 0.762)	<0.001	0.587 (0.353, 0.747)	<0.001
<b>PCR Positivity<sup>**</sup></b>						
2020 – 2021	0.695 (0.506, 0.815)	<0.001	0.721 (0.542, 0.833)	<0.001	0.679 (0.480, 0.806)	<0.001
2021 – 2022	0.190 (-0.105, 0.451)	0.202	0.149 (-0.149, 0.420)	0.325	0.136 (-0.162, 0.409)	0.369

\*School closure is defined as a transition from being open to being closed for in-person instruction excluding any scheduled days off; fully in-person and hybrid learning modalities are classified as open, and fully remote and closed are classified as closed.

<sup>†</sup>School year: 2020-2021 (July 27, 2020 to June 30, 2021), 2021-2022 (Aug 1, 2021 to Jun 30, 2022).

<sup>‡</sup>School winter break was excluded from the analysis. The break is understood to be approximately 2 weeks in length, however, the start and end dates vary by school and district. Winter breaks consistently overlap on the last week of the year, which was epidemiological week 53 in 2020 and epidemiological week 52 in 2021. In 2020, we calculated correlations excluding winter break at epidemiological week 53, weeks 52-53, and weeks 53-1. In 2021, correlations were calculated excluding winter break at epidemiological week 52, weeks 51-52, and weeks 52-1.

<sup>§</sup>Transmission-related reasons include COVID-19 cases, suspected cases, increased student absenteeism, increased staff absenteeism, cluster or widespread transmission in the community, state or local guidance/mandate to close schools in response to COVID-19, to clean/disinfect school facilities, and other.

<sup>¶</sup>Total school closures include both transmission and non-transmission-related school closures. Transmission-related reasons include COVID-19 cases, suspected cases, increased student absenteeism, increased staff absenteeism, cluster or widespread transmission in the community, state or local guidance/mandate to close schools in response to COVID-19, to clean/disinfect school facilities, and other. Non-transmission-related reasons include COVID-19 vaccinations and side effects of vaccination of staff/students, teacher/staff shortage, for student/staff mental health, and other reasons associated with COVID-19.

<sup>#</sup>Data on COVID-cases and COVID-associated deaths were available from data.cdc.gov (8).

<sup>\*\*</sup>PCR positivity was calculated from the number of new positive results divided by the total number of new results reported. Data on PCR testing were available from HealthData.gov (10).

Note: Spearman rank correlations were used to evaluate the relationship between COVID-associated cases, deaths, and PCR-positivity (epidemiological weeks 31 through 26).

**Table 4. Weekly correlation between COVID-related school closures (SC)\* and laboratory-confirmed COVID-19-associated hospitalizations<sup>†</sup> by school year<sup>‡</sup>— United States, July 27, 2020—June 30, 2022**

	Weeks Considered as the Winter School Break <sup>§</sup>					
	Week 53/52		(Weeks 52 & 53)/(51 & 52)		(Weeks 53 & 1)/(52 & 1)	
Transmission-related SCs <sup>¶</sup>						
	R (95% CI)	P	R (95% CI)	P	R (95% CI)	P
<b>2020-2021</b>						
All ages	0.639 (0.420, 0.783)	<0.001	0.650 (0.431, 0.791)	<0.001	0.618 (0.387, 0.770)	<0.001
0-4 years	0.403 (0.119, 0.620)	0.006	0.406 (0.120, 0.625)	0.006	0.367 (0.074, 0.596)	0.014
5-17 years	0.373 (0.085, 0.598)	0.011	0.378 (0.087, 0.604)	0.011	0.339 (0.043, 0.575)	0.024
18-49 years	0.548 (0.298, 0.722)	<0.001	0.548 (0.294, 0.723)	<0.001	0.520 (0.258, 0.705)	<0.001
50-64 years	0.622 (0.396, 0.771)	<0.001	0.630 (0.404, 0.778)	<0.001	0.599 (0.362, 0.758)	<0.001
65 plus years	0.669 (0.461, 0.802)	<0.001	0.685 (0.480, 0.813)	<0.001	0.650 (0.431, 0.791)	<0.001
<b>2021-2022</b>						
All ages	0.812 (0.667, 0.894)	<0.001	0.803 (0.650, 0.890)	<0.001	0.798 (0.641, 0.886)	<0.001
0-4 years	0.357 (0.051, 0.596)	0.021	0.321 (0.006, 0.572)	0.043	0.308 (-0.008, 0.563)	0.053
5-17 years	0.687 (0.474, 0.818)	<0.001	0.676 (0.454, 0.813)	<0.001	0.663 (0.436, 0.805)	<0.001
18-49 years	0.761 (0.586, 0.864)	<0.001	0.750 (0.565, 0.858)	<0.001	0.743 (0.555, 0.854)	<0.001
50-64 years	0.827 (0.692, 0.903)	<0.001	0.820 (0.677, 0.899)	<0.001	0.814 (0.668, 0.896)	<0.001
65 plus years	0.700 (0.494, 0.827)	<0.001	0.685 (0.468, 0.818)	<0.001	0.677 (0.457, 0.814)	<0.001

Total SCs <sup>#</sup>						
<b>2020-2021</b>						
All ages	0.651 (0.437, 0.791)	<0.001	0.675 (0.467, 0.807)	<0.001	0.631 (0.405, 0.779)	<0.001
0-4 years	0.386 (0.100, 0.608)	0.008	0.401 (0.114, 0.621)	0.007	0.349 (0.054, 0.582)	0.020
5-17 years	0.351 (0.060, 0.581)	0.018	0.368 (0.075, 0.596)	0.014	0.315 (0.016, 0.557)	0.037
18-49 years	0.533 (0.278, 0.712)	<0.001	0.5444 (0.288, 0.721)	<0.001	0.503 (0.237, 0.693)	<0.001
50-64 years	0.630 (0.407, 0.776)	<0.001	0.651 (0.432, 0.791)	<0.001	0.608 (0.373, 0.763)	<0.001
65 plus years	0.720 (0.535, 0.834)	<0.001	0.752 (0.580, 0.855)	<0.001	0.705 (0.510, 0.826)	<0.001
<b>2021-2022</b>						
All ages	0.708 (0.518, 0.827)	<0.001	0.693 (0.492, 0.818)	<0.001	0.689 (0.486, 0.815)	<0.001
0-4 years	0.470 (0.200, 0.668)	0.001	0.442 (0.162, 0.650)	0.002	0.433 (0.152, 0.644)	0.003
5-17 years	0.646 (0.429, 0.787)	<0.001	0.630 (0.404, 0.778)	<0.001	0.621 (0.391, 0.772)	<0.001
18-49 years	0.645 (0.427, 0.786)	<0.001	0.625 (0.397, 0.775)	<0.001	0.620 (0.390, 0.771)	<0.001
50-64 years	0.723 (0.539, 0.836)	<0.001	0.708 (0.514, 0.828)	<0.001	0.704 (0.508, 0.825)	<0.001
65 plus years	0.677 (0.472, 0.806)	<0.001	0.659 (0.443, 0.797)	<0.001	0.654 (0.437, 0.793)	<0.001

<sup>\*</sup>School closure is defined as a transition from being open to being closed for in-person instruction excluding any scheduled days off; fully in-person and hybrid learning modalities are classified as open, and fully remote and closed are classified as closed.

<sup>†</sup>Data on laboratory-confirmed COVID-19-associated hospitalizations was available from COVID-NET(9).

<sup>‡</sup>School year: 2020-2021 (July 27, 2020 to June 30, 2021), 2021-2022 (Aug 1, 2021 to Jun 30, 2022).

<sup>§</sup>School winter break was excluded from the analysis. The break is understood to be approximately 2 weeks in length, however, the start and end dates vary by school and district. Winter breaks consistently overlap on the last week of the year, which was epidemiological week 53 in 2020 and epidemiological week 52 in 2021. In 2020, we calculated correlations excluding winter break at epidemiological week 53, weeks 52-53, and weeks 53-1. In 2021, correlations were calculated excluding winter break at epidemiological week 52, weeks 51-52, and weeks 52-1.

<sup>¶</sup>Transmission-related reasons include COVID-19 cases, suspected cases, increased student absenteeism, increased staff absenteeism, cluster or widespread transmission in the community, state or local guidance/mandate to close schools in response to COVID-19, to clean/disinfect school facilities, and other.

<sup>#</sup>Total school closures include both transmission and non-transmission-related school closures. Transmission-related reasons include COVID-19 cases, suspected cases, increased student absenteeism, increased staff absenteeism, cluster or widespread transmission in the community, state or local guidance/mandate to close schools in response to COVID-19, to clean/disinfect school facilities, and other. Non-transmission-related reasons include COVID-19 vaccinations and side effects of vaccination of staff/students, teacher/staff shortage, for student/staff mental health, and other reasons associated with COVID-19.

Note: Spearman rank correlations were used to evaluate the relationship between COVID-associated hospitalization (epidemiological weeks 31 through 26).



## Figures

### **Fig 1. COVID-19-related School Closures<sup>\*†‡</sup> and Dominant COVID-19 Variants<sup>§</sup>, United States, July 27, 2020 – June 30, 2022**

<sup>\*</sup> School closure is defined as a transition from being open to being closed for in-person instruction excluding any scheduled days off; fully in-person and hybrid learning modalities are classified as open, and fully remote and closed are classified as closed.

<sup>†</sup> Transmission-related reasons include COVID-19 cases, suspected cases, increased student absenteeism, increased staff absenteeism, cluster or widespread transmission in the community, state or local guidance/mandate to close schools in response to COVID-19, to clean/disinfect school facilities, and other.

<sup>‡</sup> Non-transmission-related reasons include COVID-19 vaccinations and side effects of vaccination of staff/students, teacher/staff shortage, for student/staff mental health, and other reasons associated with COVID-19.

<sup>§</sup> Timeline of COVID-19 variants derived from CDC Museum COVID-19 Timeline (30) and defined as the point at which a variant comprised the largest proportion of cases.

<sup>¶</sup> Emergency Use Authorization (EUA) by the Food and Drug Administration (FDA) authorized COVID-19 vaccination for teachers and staff as part of the essential workforce on March 2, 2021, and all those 16 years of age or older on April 19, 2021 (29). Advisory Committee on Immunization Practices (ACIP) recommended COVID-19 vaccination for 12-15 years on May 12, 2021, and for 5-11 years on November 2, 2021 (30).

### **Fig 2. COVID-19-related School Closures<sup>\*†‡</sup> and COVID-related cases<sup>§</sup>, deaths<sup>§</sup>, and PCR positivity<sup>¶</sup> by school year<sup>#</sup>, United States, July 27, 2020 – June 30, 2022**

<sup>\*</sup> School closure is defined as a transition from being open to being closed for in-person instruction excluding any scheduled days off; fully in-person and hybrid learning modalities are classified as open, and fully remote and closed are classified as closed.

<sup>†</sup> Transmission-related reasons include COVID-19 cases, suspected cases, increased student absenteeism, increased staff absenteeism, cluster or widespread transmission in the community, state or local guidance/mandate to close schools in response to COVID-19, to clean/disinfect school facilities, and other.

<sup>‡</sup> Non-transmission-related reasons include COVID-19 vaccinations and side effects of vaccination of staff/students, teacher/staff shortage, for student/staff mental health, and other reasons associated with COVID-19.

<sup>§</sup> Data on COVID-cases and COVID-associated deaths (8).

<sup>¶</sup> PCR positivity was calculated from the number of new positive results divided by the total number of new results reported. Data on PCR testing (10).

<sup>#</sup> School year: 2020-2021 (July 27, 2020 to June 30, 2021), 2021-2022 (Aug 1, 2021 to Jun 30, 2022).

### **Fig 3. COVID-19-related School Closures<sup>\*†‡</sup> and Laboratory-confirmed COVID-19-related Hospitalization by Age<sup>§</sup>, United States, July 27, 2020 – June 30, 2022**

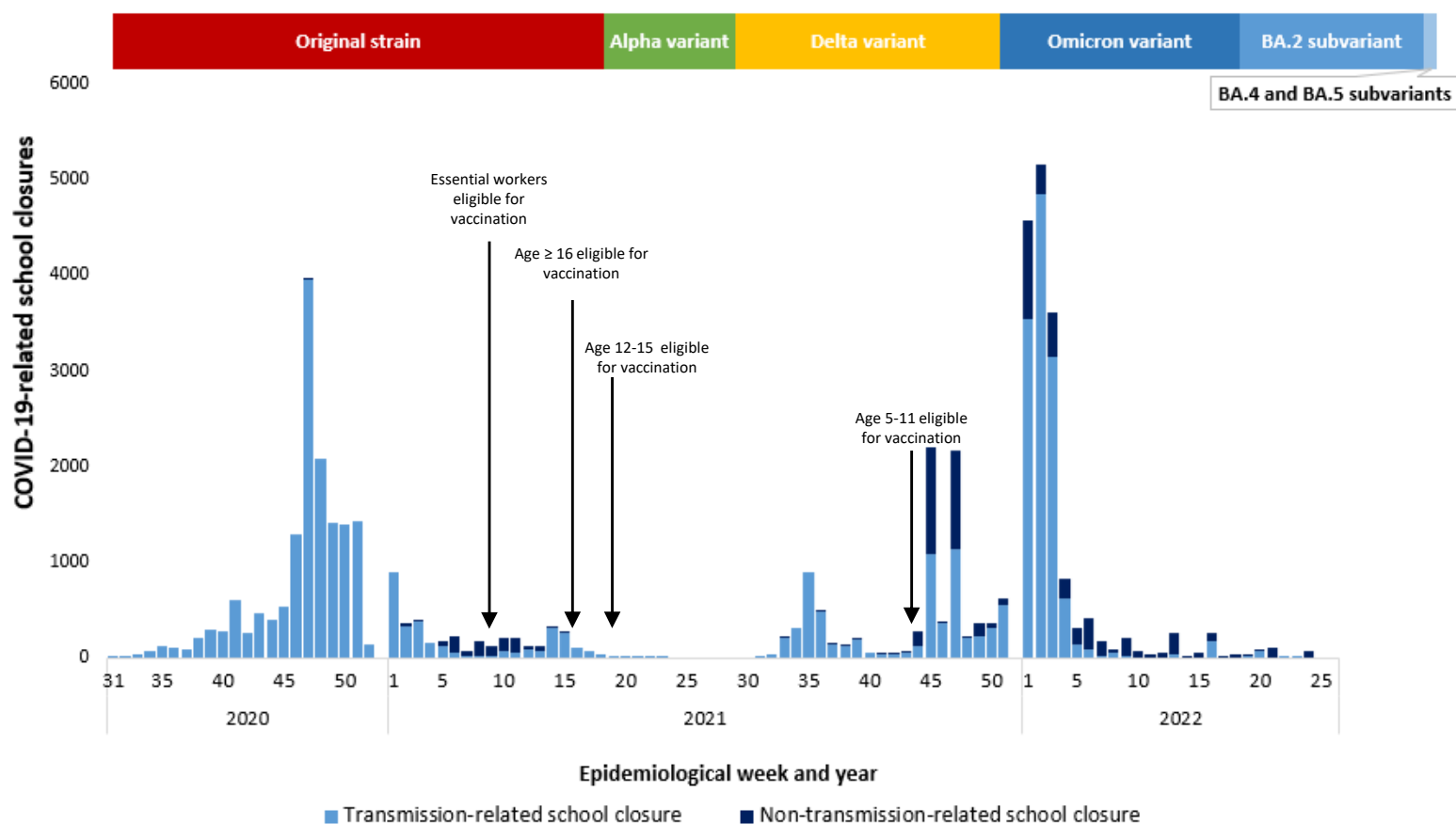
<sup>\*</sup> School closure is defined as a transition from being open to being closed for in-person instruction excluding any scheduled days off; fully in-person and hybrid learning modalities are classified as open, and fully remote and closed are classified as closed.

<sup>†</sup> Transmission-related reasons include COVID-19 cases, suspected cases, increased student absenteeism, increased staff absenteeism, cluster or widespread transmission in the community, state or local guidance/mandate to close schools in response to COVID-19, to clean/disinfect school facilities, and other.

<sup>‡</sup> Non-transmission-related reasons include COVID-19 vaccinations and side effects of vaccination of staff/students, teacher/staff shortage, for student/staff mental health, and other reasons associated with COVID-19.

<sup>§</sup> Data on laboratory-confirmed COVID-19-associated hospitalizations (9).

**Figure 1. COVID-19-related School Closures<sup>\*†‡</sup> and Dominant COVID-19 Variants<sup>§</sup>, United States, July 27, 2020 – June 30, 2022**



\*School closure is defined as a transition from being open to being closed for in-person instruction excluding any scheduled days off; fully in-person and hybrid learning modalities are classified as open, and fully remote and closed are classified as closed.

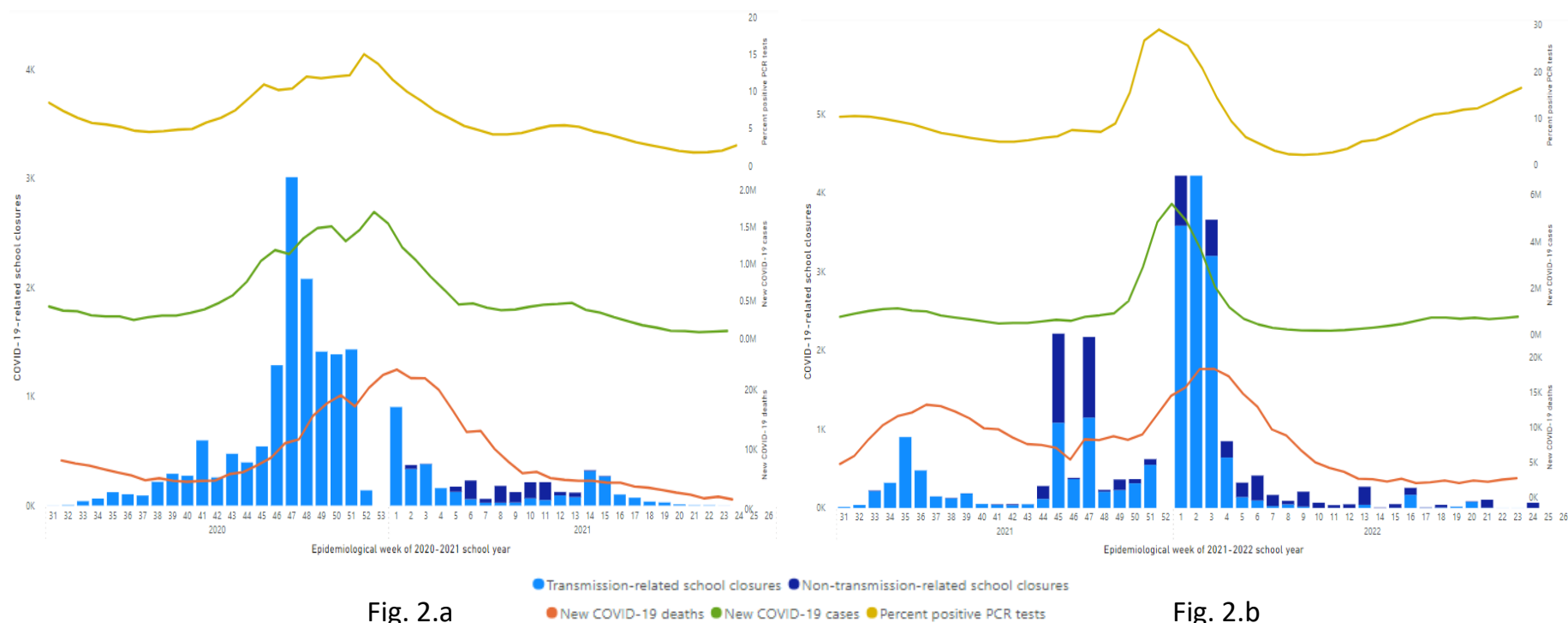
†Transmission-related reasons include COVID-19 cases, suspected cases, increased student absenteeism, increased staff absenteeism, cluster or widespread transmission in the community, state or local guidance/mandate to close schools in response to COVID-19, to clean/disinfect school facilities, and other.

‡ Non-transmission-related reasons include COVID-19 vaccinations and side effects of vaccination of staff/students, teacher/staff shortage, for student/staff mental health, and other reasons associated with COVID-19.

§Timeline of COVID-19 variants derived from CDC Museum COVID-19 Timeline (30) and defined as the point at which a variant comprised the largest proportion of cases.

¶Emergency Use Authorization (EUA) by the Food and Drug Administration (FDA) authorized COVID-19 vaccination for teachers and staff as part of the essential workforce on March 2, 2021, and all those 16 years of age or older on April 19, 2021 (29). Advisory Committee on Immunization Practices (ACIP) recommended COVID-19 vaccination for 12-15 years on May 12, 2021, and for 5-11 years on November 2, 2021 (30).

**Figure 2. COVID-19-related School Closures<sup>\*†‡</sup> and COVID-related cases<sup>§</sup>, deaths<sup>§</sup>, and PCR positivity<sup>¶</sup> by school year<sup>#</sup>, United States, July 27, 2020 – June 30, 2022**



\*School closure is defined as a transition from being open to being closed for in-person instruction excluding any scheduled days off; fully in-person and hybrid learning modalities are classified as open, and fully remote and closed are classified as closed.

†Transmission-related reasons include COVID-19 cases, suspected cases, increased student absenteeism, increased staff absenteeism, cluster or widespread transmission in the community, state or local guidance/mandate to close schools in response to COVID-19, to clean/disinfect school facilities, and other.

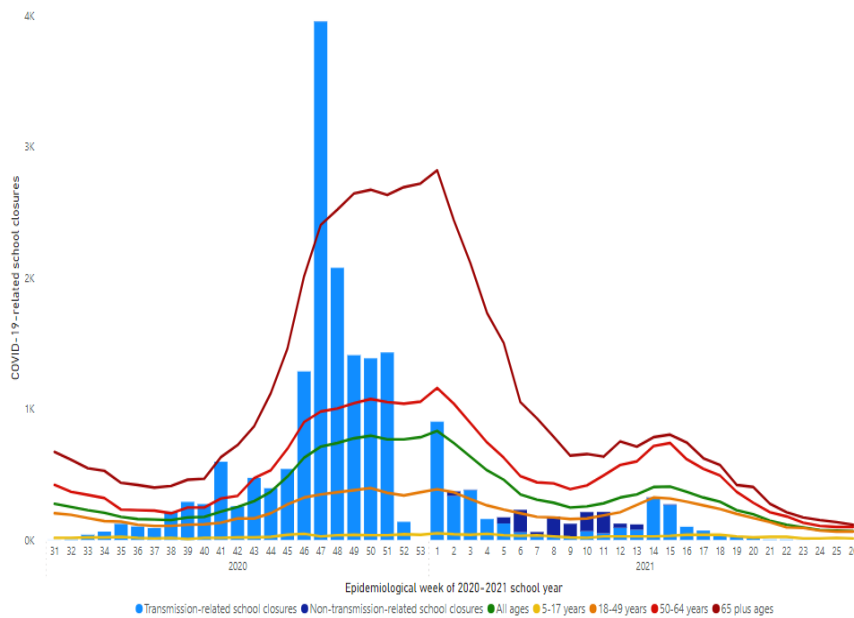
‡Non-transmission-related reasons include COVID-19 vaccinations and side effects of vaccination of staff/students, teacher/staff shortage, for student/staff mental health, and other reasons associated with COVID-19.

§Data on COVID-cases and COVID-associated deaths (8)

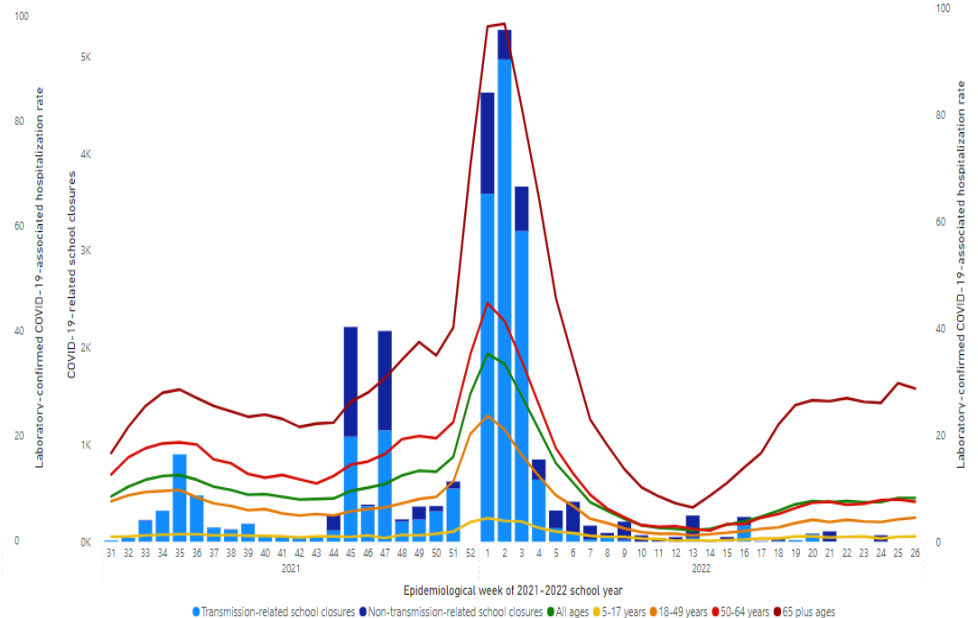
¶PCR positivity was calculated from the number of new positive results divided by the total number of new results reported. Data on PCR testing (10).

#School year: 2020-2021 (July 27, 2020 to June 30, 2021), 2021-2022 (Aug 1, 2021 to Jun 30, 2022).

**Figure 3. COVID-19-related School Closures<sup>\*†‡</sup> and Laboratory-confirmed COVID-19-related Hospitalization by Age<sup>§</sup>, United States, July 27, 2020 – June 30, 2022**



**Fig. 3.a**



**Fig. 3.b**

\*School closure is defined as a transition from being open to being closed for in-person instruction excluding any scheduled days off; fully in-person and hybrid learning modalities are classified as open, and fully remote and closed are classified as closed.

† Transmission-related reasons include COVID-19 cases, suspected cases, increased student absenteeism, increased staff absenteeism, cluster or widespread transmission in the community, state or local guidance/mandate to close schools in response to COVID-19, to clean/disinfect school facilities, and other.

‡ Non-transmission-related reasons include COVID-19 vaccinations and side effects of vaccination of staff/students, teacher/staff shortage, for student/staff mental health, and other reasons associated with COVID-19.

§ Data on laboratory-confirmed COVID-19-associated hospitalizations (9)