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The University of Texas at Austin

COVID-19 Campus Introduction Risks for School Reopenings

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Summary

The COVID-19 pandemic threatens most Texas cities. As of July 21, 2020, Texas has reported 340,000 confirmed cases and nearly 4,200 deaths. School districts statewide are developing plans to offer in-person education that meet the social and educational needs of students while mitigating the risk of COVID-19 to students, staff, faculty, their families and the surrounding communities. The level of risk for a particular school or school system will stem from three factors:

1. *Introduction risks*: the chance that students and staff will be infected outside of school and arrive at school while infected.
2. *On-campus transmission risks*: the chance that transmission will occur within schools if and when students or staff arrive infected.
3. *Community amplification risks:* the chance that individuals infected within schools will subsequently transmit the virus to individuals in the surrounding community.

To address the first of these three components, this report provides a simple calculation for estimating the rate at which COVID-19 may appear on school campuses depending on the background prevalence of the virus in the surrounding community.

Background

COVID-19 emerged in China in late 2019, and quickly spread around the world in early 2020. Given its rapid spread and large numbers of hospitalizations and deaths, most regions made the difficult decision to suspend in-person teaching almost immediately upon detecting local cases. These decisions were based partly on research suggesting that schools accelerate community transmission of respiratory viruses like influenza and milder seasonal coronaviruses. Given that schools throughout the US have largely remained closed since mid-March and other countries have sporadically opened schools with highly variable strategies and success, there is still uncertainty regarding the risks to students, staff and the surrounding community.

The National Academy of Sciences, Engineering, and Medicine just published an in-depth analysis of the challenges and priorities for opening schools during the COVID-19 pandemic, entitled *Reopening K-12 Schools During the COVID-19 Pandemic: Prioritizing Health, Equity, and Communities (2020)[1]*. It notes that “School systems will need to take local epidemiology into account when making decisions about whether and how to open and close.” Regions that have mostly eliminated COVID-19 may be able to offer in-person schooling with sensible precautions, whereas others fighting COVID-19 surges may find it infeasible to reopen safely regardless of precautionary measures.

Here, we provide a simple approach to help decision-makers and educators gauge the feasibility of bringing students and staff to campus. Based on the prevalence of the virus in a given Texas community, we calculate the school *introduction risk*—that is, the number of students and staff we would expect to arrive at school during the first week of the school year.

Calculating school introduction risk

To calculate the expected number of imported infections into a school in a given week, one needs to know two quantities:

> *N*: the size of the school (number of students and staff)
>
> *P*: the probability a student or staff member recently became infected outside of school

The expected number of students/staff that will arrive infected during that week is then the product of these two quantities ($N \cdot P$). While *N* is straightforward–simply the total number of students and staff that will come to campus during the first week–*P* must be approximated. We assume that it is equal to the prevalence of COVID-19 in the surrounding community. For example, if 3% of people in the surrounding community are infected during a given week, then we would assume that 3 out of every 100 students and staff are likewise infected.

Table 1 gives the expected number of students/staff that will arrive at school infected during a given week, for different levels of COVID-19 prevalence (ranging from 1 in 1000 to 5 in 100 infected) and school size (ranging from 25 to 2000 students/staff on campus). Figure 1 shows the probability that <u>at least one</u> student or staff member will arrive infected in a week under a few of the same scenarios. Regardless of school size, if local prevalence is high, schools should expect to have many infected students and staff introducing the virus. The following section outlines how local officials can estimate their prevalence so that they can estimate their own risk.

Table 1: Number of students/staff that will arrive infected during one week of the school year depending on the size of the school and the background prevalence of COVID-19 in the community. Gray cells indicate prevalence and school size scenarios in which we would not even expect one student/staff to be infected.

	School size – total students and teachers on campus							
COVID-19 Prevalence	**25**	**50**	**75**	**100**	**200**	**500**	**1000**	**2000**
1 in 1000 (0.1%)	<1	<1	<1	<1	<1	<1	1	2
5 in 1000 (0.5%)	<1	<1	<1	<1	1	2.5	5	10
1 in 100 (1%)	<1	<1	<1	1	2	5	10	20
2 in 100 (2%)	<1	1	1.5	2	4	10	20	40
3 in 100 (3%)	<1	1.5	2.25	3	6	15	30	60
4 in 100 (4%)	1	2	3	4	8	20	40	80
5 in 100 (5%)	1.25	2.5	3.75	5	10	25	50	100

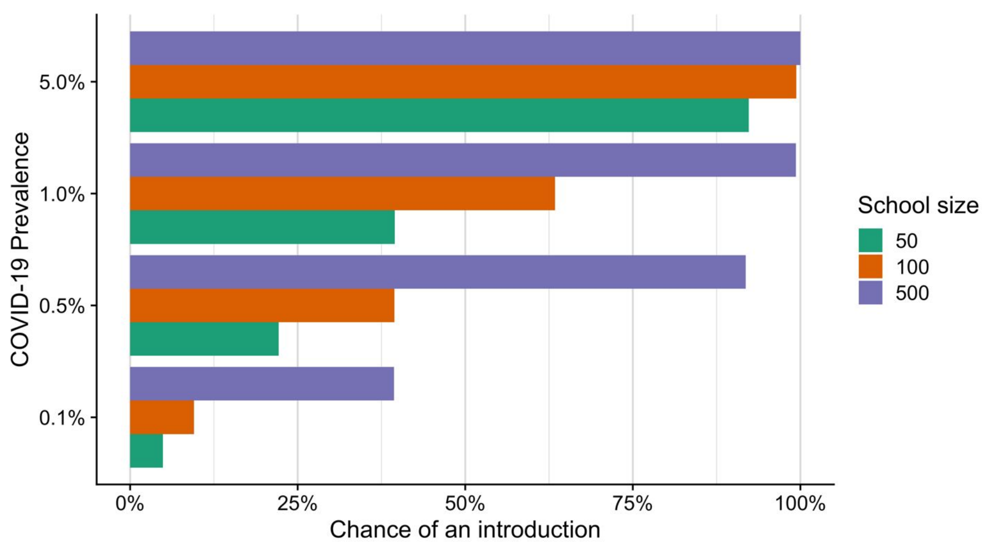

Figure 1. Probability that at least one student or staff member will introduce COVID-19 into a school in a week, depending on the current prevalence of the virus in the community and the size of the school.

Estimating the local prevalence of COVID-19

To approximate the chance that a given student or staff member may be infected, we suggest that decision-makers use the local prevalence of COVID-19, that is, the fraction of the population who are currently infected and capable of infecting others.

There are three pieces of information needed to estimate the fraction of the population that is infectious:

1. The number of new infections each day
2. How long each case remains infectious
3. The total population size

Confirmed case data can be used to estimate the total number of new infections in a community, but do not provide a complete accounting of all cases. A large fraction of infected cases may never develop symptoms or only feel mildly ill. Even cases with clear symptoms, may never seek or may not have adequate access to testing. In some counties, as few as 10% of total infections are reported [2].

Using comprehensive COVID-19 hospitalization data from Austin [3], we have estimated the case reporting rate over the course of the pandemic and found that approximately one in three infections is reported in the five-county metropolitan area. In other words, we can approximate the total number of new cases in a given week by tripling the number of reported cases. Preliminary analysis of all 22 Trauma Service Areas (TSA's) in Texas suggest that the reporting rates range from 1 in 3 estimated in the Austin TSA to 1 in 10 estimated in the Lower Rio Grande Valley TSA.

Given this range, we suggest estimating risk based on both ends of this range, as follows:

1. Obtain case data for the focal counties from the Johns Hopkins University [4] or New York Times [5] datasets.
2. Sum up the number of new infections over the past 14 days[1].
3. Multiply that sum by three and by ten to get a lower and upper estimate for the current number of infectious cases.
4. Divide by the population size in the focal counties.

[1] This assumes that cases remain infectious for 14 days following infection [6,7] and that prevalence is relatively stable from one week to the next. This will underestimate risk if counties are experiencing rapid epidemic growth and overestimate risk if counties are experiencing declining epidemics.

Example: COVID-19 school introduction risks in Texas counties

To demonstrate the method, we have estimated the risks of introductions if schools were opened this week (July 20-24) in each Texas county (see this spreadsheet for the full set of results). As examples, Figure 2 provides estimates for three larger counties that are experiencing various levels of COVID-19 spread: Denton, Harris, and Hidalgo. This is **not** meant to indicate the long-term feasibility of school openings in these communities, but rather to highlight the heterogeneous and rapidly changing risks throughout Texas. As communities succeed in slowing transmission and reducing prevalence, the introduction risks will decline. Based on mid-July prevalence, this risk assessment approach suggests that a school of 100 individuals should expect roughly 1-2 COVID-19 introductions in the first week in Denton county, 1-4 introductions in Harris county, and 2-8 introductions in Hidalgo county (Figure 2). As described above, these estimates are based on prevalence estimates from the most recent 14 days of reported cases and assume that the true number of infections in the counties are between three or ten times the reported cases.

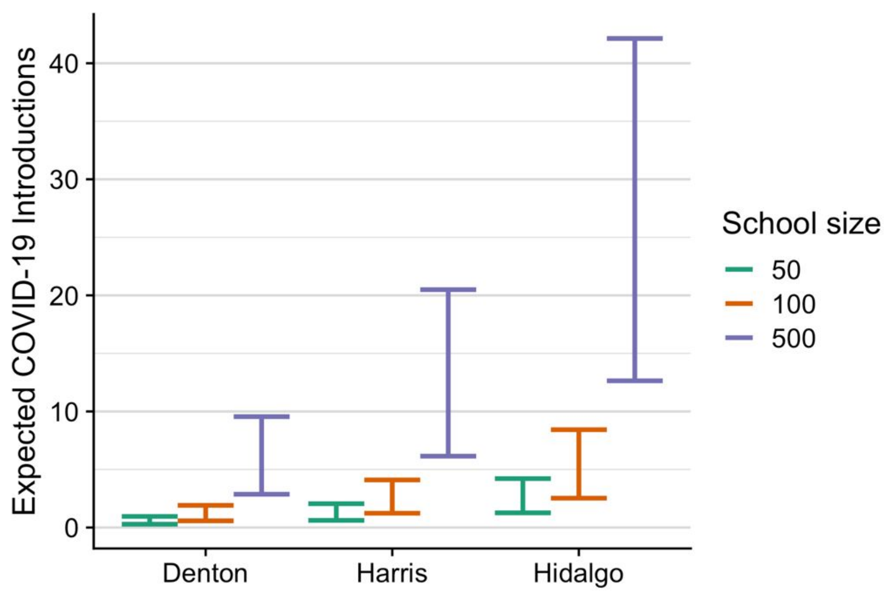

Figure 2: Expected number of infected students/staff arriving in a given week, based on the prevalence of COVID-19 estimated for Denton, Harris and Hidalgo counties for July 20-24. These large counties from different regions of the state were selected to represent the wide range of COVID-19 risk experienced across the state in mid-July. The different colors correspond to school sizes, that is, the total number of students and staff on campus. The bottoms of each bar assume that true prevalence is triple the reported cases and tops assume that prevalence is 10 times the reported cases.

Across the state, counties are experiencing variable levels of COVID-19 prevalence as of July 21, 2020. This corresponds to introduction risks ranging from 0 to 8 infections in one week into a school with 100 staff and students (see Figure 3 and the full table of estimates). While some counties have had no reported cases in the preceding week, nearly 97% have non-zero risk (Figure 3A). As of July 21, 2020, 40.1% (104) of Texas' 254 counties covering 74.1% of the Texas population would expect at least one COVID-19 introduction into each school of size 100 (Figure 3B).

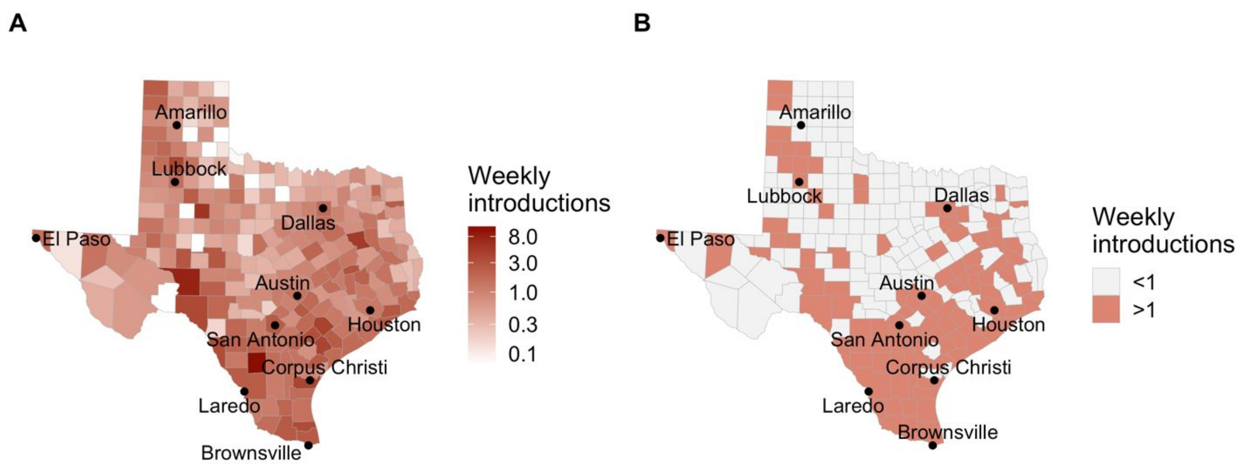

Figure 3: County-level risk map for COVID-19 introductions into a school, assuming 100 students and staff on campus, based prevalence estimated for July 20-24, 2020. (A) Shading indicates the expected number of introductions in a week assuming today's conditions. Note that colors are on a log-scale given the nearly 100-fold range in estimated risk. Specifically, we estimate prevalence by calculating three times the number of newly reported cases over the preceding 14 days. (B) Counties in red are those in which at least one student/staff would be expected to arrive infected during the week of July 20-24. As of July 21, 2020, 40.1% (104) of Texas' 254 counties covering 74.1% of the Texas population are in this high risk category.

Final considerations

To support school planning in the months ahead, the estimates provided herein should be revised to reflect the evolving state of the COVID-19 pandemic across Texas. Our approach can be broadly applied to provide situational awareness in communities across the US and closely resembles the methodology used by Georgia Tech's COVID-19 Event Risk Assessment Planning Tool.

The guidance above makes a key assumption: the chance that a student will arrive at school infected can be approximated by the overall prevalence of COVID-19 in the surrounding community. However, there are two important issues that could lead to underestimating or overestimating a school's risk:

1. The prevalence of COVID-19 among school-aged children may differ from the overall prevalence in a community. If children have lower susceptibility to the virus or fewer daily contacts than adults, then the chance that they are infected in any given week may be lower than the overall prevalence in the community. While early reports suggested that children could be 55% (95% CI: 35-70%) less susceptible to infection than adults [8], more recent estimates suggest nearly equal susceptibility [9,10]. These guidelines should be updated as we gain more insight into the spread of COVID-19 to, from and among school-aged children.

2. Schools within the same county may have different levels of risk. If infections are occurring in localized *hot spots*, then schools in those neighborhoods will have higher risks than suggested by the overall prevalence while schools in less affected neighborhoods will have lower risk. Importantly, COVID-19 is disproportionately impacting vulnerable communities [11,12]. Socioeconomic and racial disparities in COVID-19 burden drive heterogeneity in local risks, with unfortunate overlap between high disease risk and the greatest need for the educational and social services provided by schools [1].

Thus, decision-makers should recognize that this framework provides only a rough indication of importation risk and should also consider local information regarding the variation in COVID-19 burden within their communities.

Importantly, these calculations only consider the risk that infections will be *introduced into schools* by students and staff who are infected outside of school. They do not consider the subsequent risks of transmission within and beyond the school community. Those risks will depend on precautionary measures taken by schools, individuals and families. Nonetheless, these estimates can provide insight into the feasibility of in-person schooling. If schools plan to suspend classes, grades, or entire programs upon detection of a single infection, then it may be infeasible to bring students and staff to campus until the current waves of COVID-19 subside.

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