In-Person School Operation and the COVID-19 Pandemic

James D. Martin, Ph. D. (2/9/2021)

There is much debate as to how in-person school operations impact the spread of COVID-19 in communities. That debate is heavily fueled by groups with strong personal and political interests to either open or close in-person operations. No-one disagrees that the current pandemic is putting a substantial strain on students, parents, and school staff. There are clear health, mental-health, and societal risks associated with any decision to open or close in-person operation of schools.

To understand and appropriately weigh the risks, it is necessary to have comprehensive data that is relevant to the context of actual conditions. Unfortunately, many reports regarding the safety of in-person operation of schools have been conducted on very small sample populations, during times of relatively low community spread, and with limited data collection reliability (much being self-reported, with limited contact tracing or testing of asymptomatic individuals). In addition, conclusions are frequently drawn by comparing the incidence of COVID cases in schools directly to the case frequency in the overall community. This ignores the fact that schools are made up of about 90% children (generally lower incidence of infection), whereas in North Carolina as a whole, the 5-17 year-old school age population is only 16% of the population.

Too often the results of such reports are extrapolated to extremely different population densities and infection-incidence conditions. And furthermore, their popular use often focuses on headline conclusions of "safety" with little to no attention to the clear descriptions of the conditions under which the studies were conducted (e.g. masking, social distance, hybrid operation, etc.).

While we are extremely fortunate that, to date, there have been no major outbreaks among school populations, analysis of data reported to the North Carolina Department of Health and Human Services demonstrates multiple correlations between changes in in-person school activity and the observed incidence of COVID cases in the community. Here in Wake County, NC, young children have exhibited the greatest relative increase in the incidence of COVID cases of any population cohort group since our public schools have been offering in-person schooling and high school athletics.

North Carolina data does not appear to support claims that "transmission in schools is far lower than the surrounding community." And thus, from a policy standpoint, in-person school operation should not occur with less restrictive preventative measures such as masking, distancing, size of gatherings, etc. than other sectors of the community.

The Data:

My analysis combines the weekly number of COVID cases reported to the NCDHHS, with 2020 population data obtained from the NC Office of State Budget and Management to obtain the cases/1000 population disaggregated into the age cohorts.

These data are presented in Figure 1.

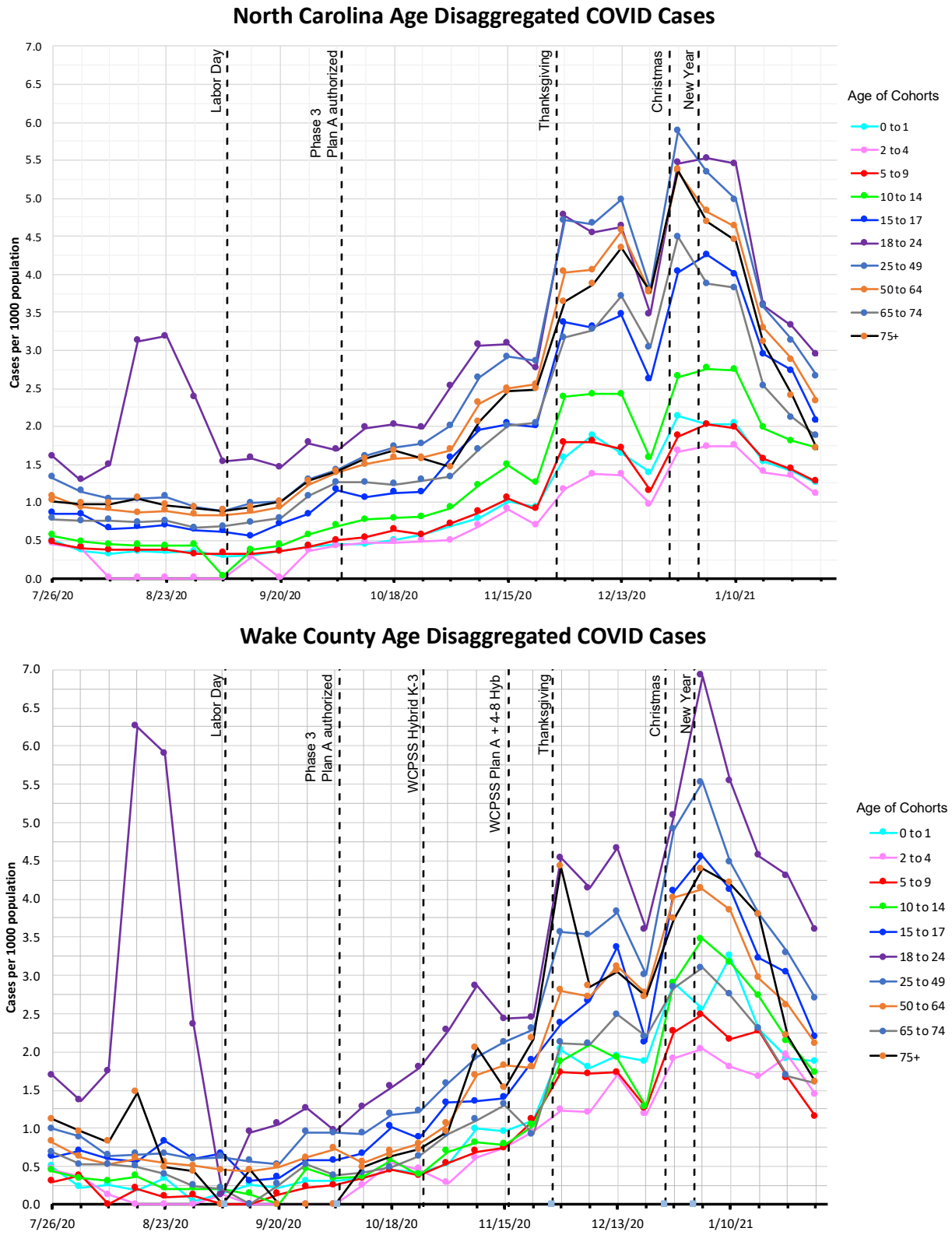
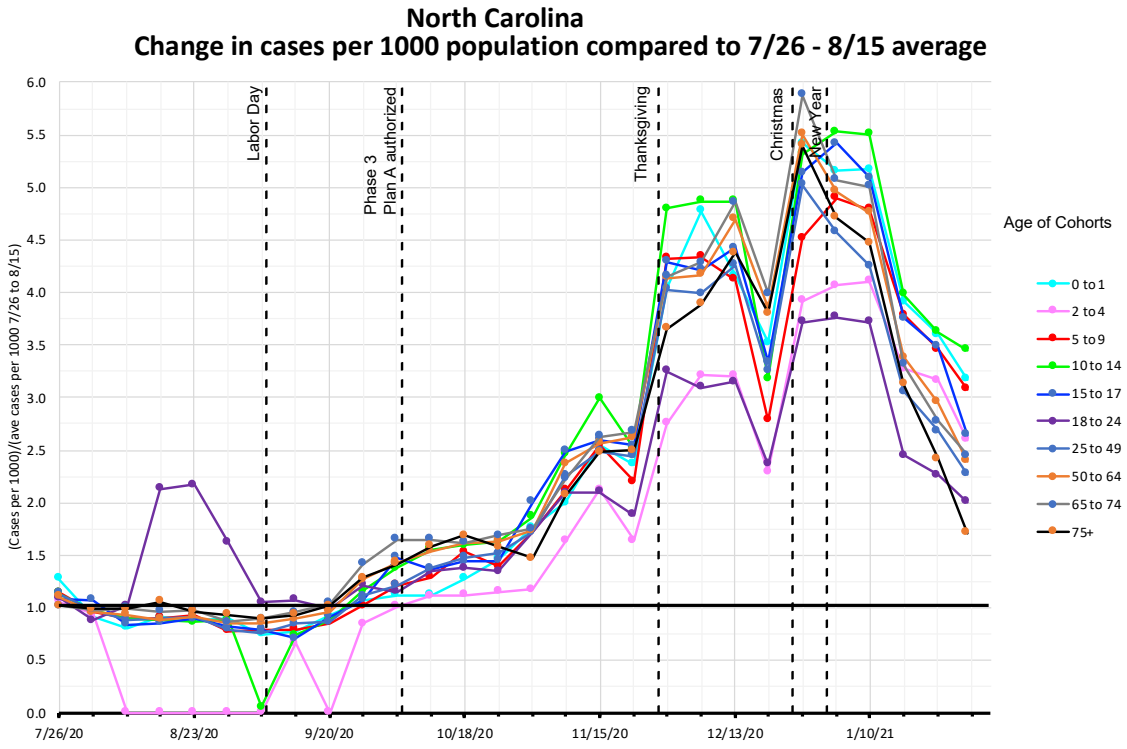


Figure 1. Age disaggregated COVID cases per 1000 population for North Carolina and Wake County, NC. Holidays and dates relevant to in-person school operation are noted as vertical dashed lines.

To examine how the incidence of cases within each age disaggregated cohort has changed over time, the weekly number of cases/1000 population of each cohort is compared to the average weekly number of cases/1000 population for the three weeks beginning 7/26/2020 and ending 8/15/2020. This was a low-incidence, relatively stable time before school openings. By dividing the weekly number of cases/1000 population of each cohort by the cohort reference value, one obtains the number of times increase or decrease in weekly cases from that reference time. Values of 1 mean there is no change from the reference timeframe. Values between 0 and 1 indicate a decrease, and values above 1 indicate an increase in the weekly cases/1000 population. These data are plotted in Figure 2. (Note, the values that drop to 0 are weeks for which no values were listed for that cohort on the NCDHHS website.)



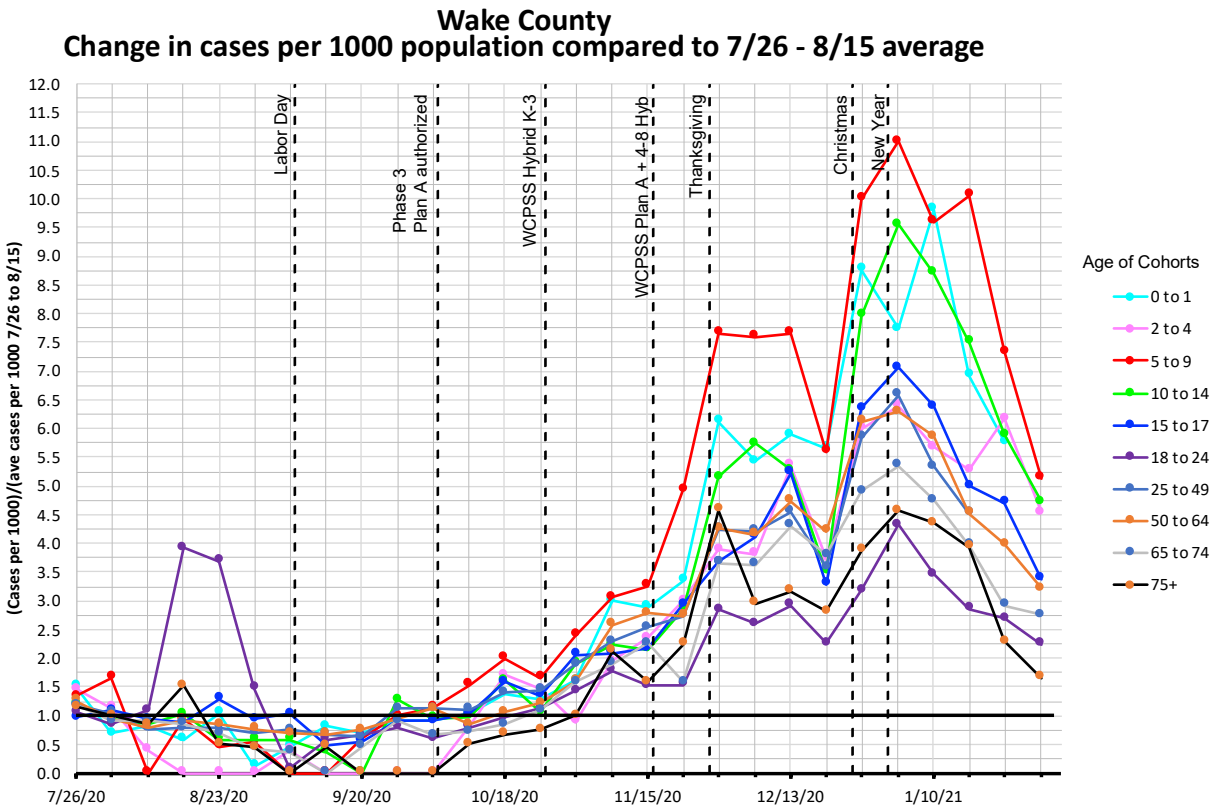


Figure 2. Changes in COVID cases per 1000 population for North Carolina and Wake County, NC, compared to the reference time of the three weeks between 7/26/2020 and 8/15/2021.

Observation 1: When you disaggregate the data by age, COVID incidence in schools mirrors community conditions.

By looking at age cohorts, we see that COVID incidence is highest in the 18-24 and 25-49 cohorts, and lowest for younger children. The approximate high-school age cohort (15-17 year-olds) tracks very close to the overall community average.

These age-based discrepancies are why we should expect schools to have lower rates of COVID than the surrounding community. This is shown in Figure 3 for a hypothetical school based on North Carolina COVID data assuming that about 90% of the school population is comprised of students from the age 5-17 cohort and the remaining 10% from the 25-64 cohort.

Studies, such as the North Carolina ABC Collaborative study,[1] conclude that schools have a lower incidence of COVID cases by comparing cases/population in schools to the those of the

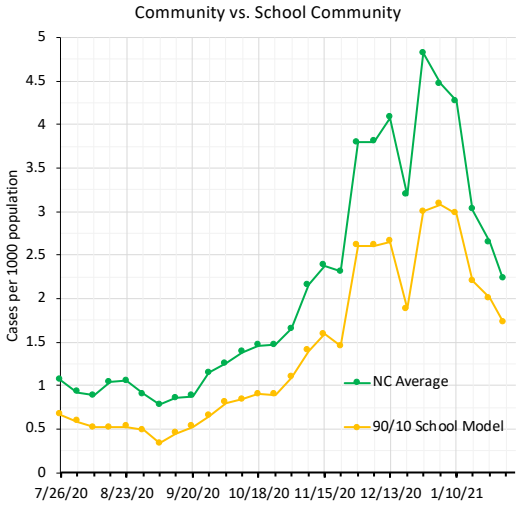


Figure 3. Average COVID cases/1000 population for North Carolina (green) compared to a hypothetical school population consisting of 90% from the 5-17 cohorts and 10% from the 25-64 cohorts (gold).

total population in the surrounding community. But a more accurate comparison between cases in schools to the school-age population of the surrounding community finds that COVID incidence in **schools is similar to, not lower than their surrounding community.**

Observation 2: Spikes in reported cases appear to correlate with in-person opening of schools.

A second clear observation in the COVID cases/1000 population is that there are notable spikes and step-points where the weekly cases/1000 population changes. The spikes and steps are clearly seen in both the total cohort/population (Figure 1) and the change in weekly cases compared to the reference time-point (Figure 2).

The first major spike in August 2020, is primarily localized in the 18-24 year-old cohort. This spike is directly correlated with the in-person opening of many colleges and universities across the state. Because of the large population of NC State University, and several other colleges and universities in Wake County, it is reasonable that this spike was greater in Wake County than was observed statewide.

There are similar identifiable spikes correlated to the Thanksgiving, Christmas, and New Year's holidays, which are observed across all age cohorts.

Notably, there is no spike or step directly following the Governor's executive order shifting the community to Phase 3 re-opening effective on October 2, 2020.

Significant changes in the number of weekly COVID cases in the Wake County data, particularly observed among the youngest age cohorts, appear to be correlated with changes in the in-person operation of the Wake County Schools System (WCPSS).

COVID cases in Wake County first begin to substantially rise between the weeks of October 25 and November 1 (Figure 2). This effect is most pronounced for the 5-9 cohort. WCPSS first opened for hybrid-in-person instruction Pre-K to 3 on October 26.

The second substantial change in weekly cases/1000 begins between the weeks of November 15 and November 22 for the 5-9 (~elementary), 10-14 (~middle) and 15-17 (~high) cohorts (also the 0-1, 2-4 and 75+ cohorts). This step precedes the Thanksgiving spike seen in the other Wake County and all NC cohorts between the weeks of November 22 and November 29. Coincident to this time, on November 16, WCPSS began daily in-person (Plan-A) operation for Pre-K to 3 and began some high school athletics. Hybrid in-person instruction for grades 6-8 began on November 9.

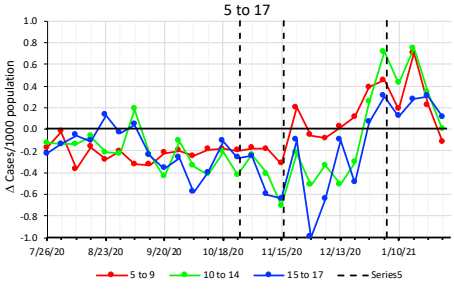


Figure 4. Differences in COVID cases/1000 population between Wake County and North Carolina. Vertical dashed lines indicate the start of hybrid in person, Plan A for WCPSS Pre-K to 3, and the return to remote instruction.

Only after these changes to school delivery did the cases/1000 population in Wake County begin to exceed the cases/1000 population in North Carolina as seen by the difference plot Figure 4; initially for the 5-9 cohort, then followed by the other school age cohorts. The Wake County average for these cohorts finally returned to the North Carolina average four weeks after returning to remote instruction following the winter holiday break. For other age cohorts, cases in Wake County remained mostly at or below the state levels, except for the 0-1 cohort, and, following the New Year's holiday, the 18-24 cohort.

Data collected by WCPSS suggests a similar Plan-A/High-School Athletics effect. WCPSS data represents self-reported data, only for those persons who have been in-person (i.e. staff and students in virtual operation who do not come into the buildings are not included). The WCPSS reporting appears to

lag the NCDHHS data by approximately one week. The weekly COVID case data disaggregated for elementary, middle and high school staff and students, as well as non-school based staff are plotted in Figures 5.

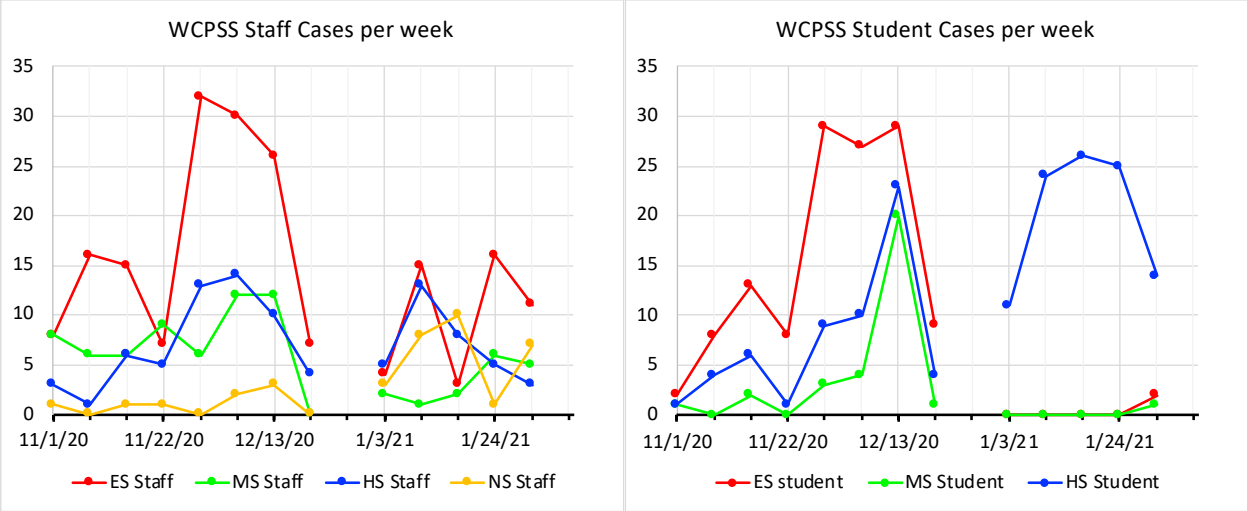


Figure 5. Total WCPSS reported weekly COVID cases disaggregated by elementary, middle, and high school staff and students as well as non-school based staff. The weeks of 11/22 and 12/20 were partial weeks resulting in incomplete reporting.

Reported cases in elementary schools increase substantially after the November 16 transition to Plan A for Pre-K to 3. With daily in-person operation, Plan A has increased density of children in classrooms, many with not even 3' of social distancing. Notably the elementary school spike precedes the Thanksgiving spike for Plan B, hybrid middle school students by two weeks. Most significantly, the WCPSS data prior to 12/13/20 shows the greatest number of reported COVID cases for elementary school students (even accounting for the larger number of elementary school grades) in contrast to the NCDHHS data that would suggest elementary cohort should exhibit the lowest number of cases/population.

High school student cases are now being reported at similar rates to when elementary school students were daily in-person, even though high school students remained remote except for extracurricular activities such as sports. The relatively high number of cases among high school students suggests that substantial COVID infection is occurring among student athletes.

Conclusions:

The above data do not answer the question as to whether or not it is possible to safely operate schools in an in-person fashion but indicate that additional caution may be warranted. The incidence of COVID infection in schools is comparable to the incidence of infection in the surrounding community. The Wake County data also strongly suggest that in-person schooling, even under hybrid models, has an identifiable impact on the community incidence of COVID infection. State health officials should examine whether dates of in-person operation similarly correlate with community incidence of COVID infections in other counties.

As indicated in the introduction, the decision to operate schools in person or not requires trade-offs between health, mental health, and societal impacts. It is critical to understand the extent to which schools affect the incidence of COVID infections. The disproportionately large increase in COVID infections in Wake County's school-aged cohorts, which appears to be correlated with in-person operation of schools, is concerning. At the same time, there are also real needs for children to have safe in-person engagement with each other and with their teachers and other adults.

Based on the above data, vaccination of school staff should be a high community priority. In addition, it seems most prudent to expect schools to at least follow the same safety protocols for masking, distancing, size of gatherings, etc. that are expected for other congregate community activities (e.g. in North Carolina, 6' of distance and no indoor gatherings of ≥10 persons when not from the same household). As clearly articulated in the January 26, 2020 article by a CDC scientist in the Journal of the American Medical Association,[2] for safe in-person operation of schools, "*all recommended mitigation measures in schools must continue: requiring universal face mask use, increasing physical distance by de-densifying classrooms and common areas, using hybrid attendance models when needed to limit the total number of contacts and prevent crowding, increasing room air ventilation, and expanding screening testing to rapidly identify and isolate asymptomatic infected individuals.*"

Dr. Martin is a member of the Wake County Board of Education. He is also a professor of Chemistry at North Carolina State University where his research is focused on chemical structure and reaction mechanisms.

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[1] "Incidence and Secondary Transmission of SARS-CoV-2 Infections in Schools," Zimmerman KO, et al. *Pediatrics*. Jan. 8, 2021. https://doi.org/10.1542/peds.2020-048090 (See Figure 2.)

[2] "Data and Policy to Guide Opening Schools Safely to Limit the Spread of SARS-CoV-2 Infection," Honein, M. A. et. al. *J. Am. Med. Assoc.*, January 26, 2021, E1-E2. doi:10.1001/jama.2021.0374