COVID-19 Simulation Integrated Model (COVSIM) to Inform Local Decision-Making

COVID-19 Modeling Projections for Schools
Part 1: Model Background
The COVSIM team is one of six modeling teams funded by CDC and the Council for State and Territorial Epidemiologists to:

(a) forecast SARS CoV-2 infections and outcomes,
(b) estimate the impact of intervention scenarios, and
(c) support state and local decision-makers.
Our Modeling Objective

To estimate the proportion of susceptible students infected throughout a school semester, depending on incoming protection as well as masking and testing policies.
Imagine a school...

- Student population: **500**
Imagine a school…

- Student population: 500
- 2-3 students begin infected with COVID-19 at the start of the semester
Imagine a school...

- Student population: 500
- 2-3 students begin infected with COVID-19 at the start of the semester
- Some students have either already had COVID-19 or have received the vaccine ("incoming protection"), or are susceptible to becoming infected

If 30% of students have had COVID-19...

...and 20% of students have received the vaccine.

Then incoming protection: 50%
Imagine a school...

- Student population: 500
- 2-3 students begin infected with COVID-19 at the start of the semester
- Some students have either already had COVID-19 or have received the vaccine ("incoming protection"), or are susceptible to becoming infected

### Elementary School Setting
- 70% Susceptible
- 30% Incoming Protection

### Middle School Setting
- 60% Susceptible
- 40% Incoming Protection

### High School School Setting
- 50% Susceptible
- 50% Incoming Protection

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Imagine a school...

- Student population: 500
- 2-3 students begin infected with COVID-19 at the start of the semester
- Some students have either already had COVID-19 or have received the vaccine ("incoming protection"), or are susceptible to becoming infected
- Every week, one new student becomes infected with COVID-19 outside the school
Imagine a school...

- Student population: 500
- 2-3 students begin infected with COVID-19 at the start of the semester
- Some students have either already had COVID-19 or have received the vaccine ("incoming protection"), or are susceptible to becoming infected
- Every week, one new student becomes infected with COVID-19 outside the school
- Availability of random RT-PCR testing and isolation among students every week
Imagine a school...

- Availability of random RT-PCR testing and isolation among students every week

- Infected Student
  - Receives Testing: Compliant (70-90%)
  - Does not Receive Testing: Noncompliant

- Isolated until recovered
- Maintains contact (can infect others)

Unknown status
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COVID-19 Modeling Projections for Schools
Part 2: Model Results
Elementary School Setting (incoming protection = 30%)

Middle School Setting (incoming protection = 40%)

High School Setting (incoming protection = 50%)

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Y axis = Percent of \textit{Susceptible} Students who have become infected

X axis = days since the school semester began (107 total days)
**Elementary School Setting**
(incoming protection = 30%)

**Middle School Setting**
(incoming protection = 40%)

**High School Setting**
(incoming protection = 50%)

"No Masking" scenarios:
effective reproductive rate = 4.0
(for every 1 person infected, 4 other students become infected)

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“Universal Masking” scenarios: effective reproductive rate = 2.0 (50% reduction in viral reproducibility from masking)
No testing

Testing ½ of students every week

Testing ½ of students

No testing

Universal Masking

No Masks

2 Levels of Testing for either masking policy
(no testing OR testing ½ of students every week)

Middle School Setting

(incoming protection = 40%)

Proportion of Susceptible Students infected with COVID-19
Middle School Setting
(incoming protection = 40%)

after 60 days....

No testing, No masking = ~80% of susceptible students have become infected

Testing students, no masking = ~60% of susceptible students have become infected

Testing students + universal masking = ~10% of susceptible students have become infected
Elementary School Setting (incoming protection = 30%)

Middle School Setting (incoming protection = 40%)

High School Setting (incoming protection = 50%)

~15% of susceptible students have become infected (30% protection)

~10% of susceptible students have become infected (40% protection)

~7% of susceptible students have become infected (50% protection)
New Infections among 500 Students after 1 semester

- Elementary School Setting (incoming protection = 30%)
- Middle School Setting (incoming protection = 40%)
- High School Setting (incoming protection = 50%)

![Bar Chart]

<table>
<thead>
<tr>
<th>Setting</th>
<th>No Masking, No Testing</th>
<th>No Masking, Testing</th>
<th>Masking, No Testing</th>
<th>Masking and Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary School</td>
<td>315</td>
<td>280</td>
<td>175</td>
<td>105</td>
</tr>
<tr>
<td>Middle School</td>
<td>255</td>
<td>225</td>
<td>163</td>
<td>105</td>
</tr>
<tr>
<td>High School</td>
<td>200</td>
<td>105</td>
<td>50</td>
<td>60</td>
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New Infections among 500 Students after 1 semester

- Elementary School Setting (incoming protection = 30%)
- Middle School Setting (incoming protection = 40%)
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</tr>
<tr>
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<td>225</td>
</tr>
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New Infections among 500 Students after 1 semester

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New Infections among 500 Students after 1 semester

\( (R_0 = 5 \text{ vs } R_0 = 4) \)

- Elementary School Setting (incoming protection = 30%)
- Middle School Setting (incoming protection = 40%)
- High School Setting (incoming protection = 50%)

![Bar chart showing new infections among 500 students after 1 semester for different settings and R0 values.](chart.png)
What does this all mean?

1. The Delta variant is very infectious; kids under 12 years old are not yet eligible for vaccines and therefore remain unprotected
2. Without masks or testing, up to 90% of susceptible students may become infected by the end of the semester (if only 30% have incoming protection)
3. Masks and testing, in combination, can prevent 40-70% of new infections (or more with high-quality, well-fitting masks)
Consequences may extend beyond the classroom and after the semester...

- Additional cases in the community--including among elderly grandparents and other family members--especially when community rates are already increasing (Goldhaber, 2021)
- More infected students leads to more days of school absences, forcing caregivers to take time off work
- Multi-inflammatory syndrome or Long-Covid, which occurs among nearly half of students and can last up to 8 months (Buonsenso, 2021a, Buonsenso 2021b)
...and if school-based infections become too great, a return to virtual learning may follow

• Virtual learning is associated with…
  – Prolonged mental health concerns among students (Golberstein, 2020)
  – Minimal or no learning gains (Engzell, 2021)
• Recall: the risk of severe disease for COVID-19 remains reduced for those of younger ages, in the event they do become infected within school

The best place for K12 children this fall is the classroom: universal masking and routine testing can ensure that they and their families remain safe and that their learning journey can continue smoothly
For additional information, please visit covsim.hosted-wordpress.oit.ncsu.edu/ or write to us at covsim-team@ncsu.edu