The Comparison of COVID Spread in Rural Schools vs Urban Schools

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MOTIVATION

Since 2019, the COVID-19 pandemic has claimed the lives of over 7 million people and is known as one of the biggest public health crisis in history [1].

One of the most packed places where COVID could spread easily is in a school. However one method that can reduce the spread is the ventilation in the school. However, in 2022 it was found that 42.8% of urban school have up to date HVAC systems while only 29.7% of rural school have up to date HVAC systems [2].

Our model is showing the difference in COVID spread between rural and urban school and how the ventilation infrastructure affects transmission risks and how students are more at risk to get COVID-19 based on the school environment and behaviors.

METHODS

We used **Agent-Based Modeling (ABM)** to simulate and analyze the spread of COVID-19 within urban and rural school settings.

Model Characteristics:

- Programming Language: MATLAB
- Inputs: Ventilation Type and Masking Rates
- Output: Infection Count/Rate of COVID-19
- Parameters model real-world data: 30% mask effectiveness based on studies and particle lifespan differences for HEPA vs. window ventilation

Table 1: Constants

Parameter	Value
Infection Rules	100% if unmasked, 30% if masked
Movement	Random within bounds Speed: 0.5 units/step
Germ Generation	5 particles every 50 timesteps
Time	720 timesteps (school day and activities)

Table 2: Changing Variables

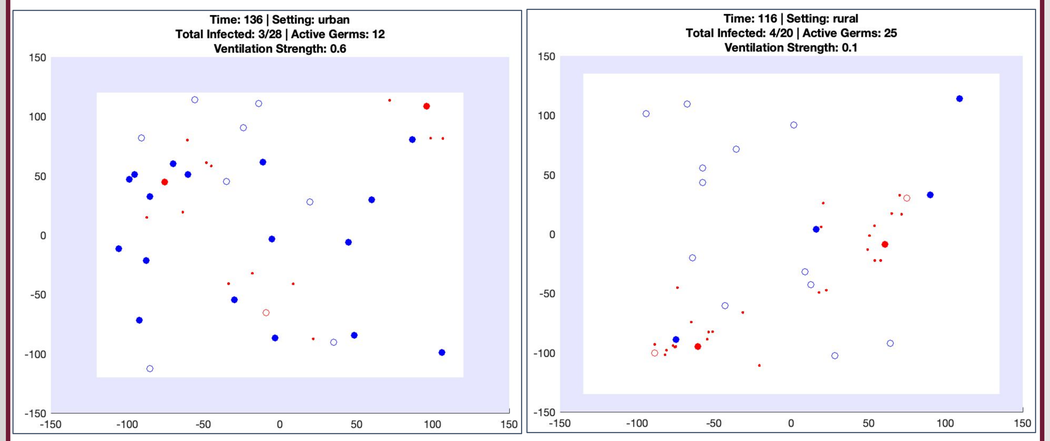
Parameter	Urban Setting	Rural Setting
Class Size	28 students [2]	20 students [2]
Initial Infected (~10%)	3 students [2]	2 students [2]
Mask Compliance	67% [2]	28% [2]
Ventilation Type	HEPA Filters [2]	Window [2]
Particle Lifespan	40 timesteps	80 timesteps

RESEARCH QUESTION

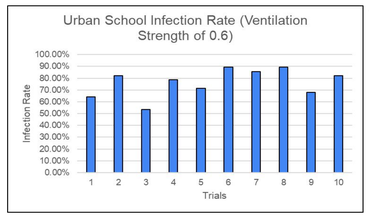
Do infrastructural disparities in ventilation systems and mask compliance rates between urban and rural schools impact COVID-19 transmission rates between students?

MODEL AND RESULTS

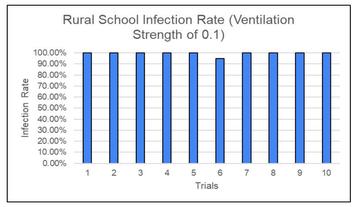
Figure 1 and 2 *show our model being used for an urban school and rural school environments.*



Figures 3 and 4 *show the percentage of infected students for each trial for both the rural and urban schools.*

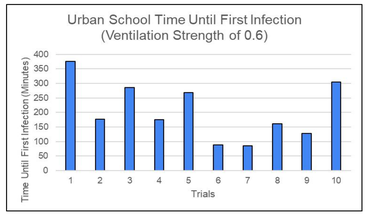


The average percentage of infected students for the urban school was 76.6 percent infected.

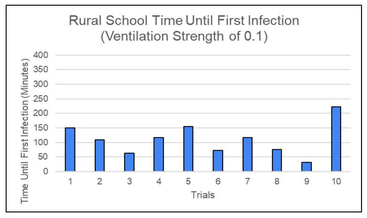


The average percentage of infected students for the rural school was 99.5 percent infected. With only one trial not becoming fully infected.

Figures 5 and 6 *show the time it took for the first student to become infected for each trial for both the rural and urban schools.*



The average time until the first infection for the urban school was 204 minutes. The urban environment had a max time of 375 minutes.



The average time until the first infection for the rural school was 112 minutes. The rural environment had a max time of 275 minutes.

DISCUSSION & CONCLUSIONS

Based on our data, we have concluded that in our simulated room of 150 X 150 units that an increase in the efficiency in ventilation will lower the amount of COVID-19 transmission and infection. In nine out of the ten trials for the rural school model 100% of the students were infected at the end of the simulation, while none of the urban school trials had the whole population infected. This shows the critical impact of ventilation in an environment where COVID-19 is present.

It was also found that the time that it took for the first person to be infected was much faster in the rural school than the urban school, showing that ventilation is an important factor in reducing COVID-19 infections.

There were multiple factors that can affect COVID-19 transmission that we could not include in our model such as:

- COVID-19 vaccinations
- individual's prior health conflicts
- Other environmental factors within the room

Overall, this data shows that as there is a decrease in ventilation quality, there will be an increase in COVID-19 transmission. This data shows how health equity is very important as less-advantaged rural schools are more susceptible to infection. Inadequate school infrastructure and masking rates in rural areas put students at much higher risk. This research indicates the need for more funding and health resources for rural schools [3].

REFERENCES

[1] World Health Organization, "WHO Coronavirus (COVID-19) Dashboard - Deaths," 2024. [Online]. Available: https://data.who.int/dashboards/covid19/deaths.

[2]: S. Pampati *et al.*, "Morbidity and Mortality Weekly Report Ventilation Improvement Strategies Among K-12 Public Schools," doi: https://doi.org/10.1101/2020.10.03.20206110v6.

[3] C. Whiting, "6 ways scientists are fighting COVID-19 that you might not know about," World Economic Forum, Nov. 19, 2020. [Online]. Available: https://www.weforum.org/stories/2020/11/covid-19-pandemics-nature-scientists/.