

COVID-19 Outbreaks in Washington State K-12 Schools: Time to first COVID-19 school
outbreak characterized by learning modality and community transmission

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Abstract

COVID-19 Outbreaks in Washington State K-12 Schools: Time to first COVID-19 school outbreak characterized by learning modality and community transmission

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BACKGROUND: There is limited research available on COVID-19 outbreaks in K-12 schools, and many schools will be looking for guidance on safely keeping schools open for the 2021-2022 school year. The primary purpose of this study was to examine the relationship between learning modality and time to assess whether there was a relationship between community level transmission and time to COVID-19 outbreak in schools.

METHODS: This study used data from the Washington State Department of Health (DOH) School Outbreak Assessment of Policies and Practices (SOAPP) survey. This is a retrospective survey designed to learn about school outbreaks and to assess the effectiveness of certain COVID-19 mitigation measures in reducing transmission in the K-12 school setting. A time-to-event analysis using the Cox Proportional Model was conducted to compare the time to the first outbreak between different learning modalities. Time to outbreak was compared between outbreaks in 100% remote, remote with exceptions, hybrid, and traditional in-person settings. Secondary analyses included community transmission of COVID-19 in the Cox Proportional Model.

RESULTS: The time-to-event analysis for the first aim did not find an association between learning modality and time to first COVID-19 outbreak. This The Cox Proportional Hazards model for the second aim met all assumptions and flagged hybrid learning modality and low transmission rate as significantly associated with time to outbreak. The p-value for hybrid learning modality was 0.008 with a hazard ratio of 4.46 (95% CI: 1.86, 10.70), indicating a strong relationship between a hybrid learning modality and increased risk of an outbreak. The p-value for low transmission rate was 0.0015 with a hazard ratio of 3.73 (95% CI: 1.65, 8.40), indicating a strong relationship between a low transmission rate and shorter time to outbreak.

CONCLUSIONS: Further research is needed to draw conclusions about the relationships between learning modality, community level transmission of COVID-19 and outbreaks in K-12 schools in Washington state.

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Introduction

Background and Significance

There is limited research available on COVID-19 transmission and outbreaks in K-12 schools in the United States. One study conducted in Wisconsin found that only 3.7% of cases reported in schools could be linked to school transmission, and that school transmission was 37% lower than community-level transmission.¹ However, the authors noted that it could be more difficult to track school outbreaks among students if there are higher rates of asymptomatic cases among children.¹ Another study in Georgia suggested that faculty and staff may play a large role in school transmission of COVID-19, especially if mitigation measures such as mask wearing and distancing are not maintained.² Community transmission is another factor to consider when observing COVID-19 outbreaks in schools. It has been shown that if community transmission is high, then students and staff are more likely to introduce COVID-19 to the school environment and possibly cause an outbreak.³

Due to the lack of information available about COVID-19 outbreaks in K-12 schools, it is important to analyze available data to gain a better understanding of these outbreaks. The Washington State Department of Health (DOH) School Outbreak Assessment of Policies and Practices (SOAPP) survey was developed to collect data to further understand COVID-19 outbreaks in K-12 schools. The questions in the survey focus on mitigation measures employed by a given school, such as mask use, and details about the outbreak. The DOH team organizing this work identified research questions that they did not have time to fully develop, which resulted in this study. This study was designed to provide information on the relationship between learning modality and community transmission on COVID-19 outbreaks in K-12 schools in Washington. There were 182 COVID-19 outbreaks reported in Washington State between August 1st, 2020 and March 31st, 2021.⁴ Many schools and school districts will be looking for guidance on safely keeping schools open for the 2021-2022 school year, and this research has the potential to help inform this guidance.

Specific Aims

This project aims to compare the time to first COVID-19 outbreak in schools by learning modality in jurisdictions with varying levels of community transmission.

Aim 1: Compare the time to first COVID-19 outbreak in schools by learning modality.

Hypothesis: Schools with more in-person instruction will have less time between school opening and first outbreak.

Aim 2: Explore the relationship between community level transmission of SARS-CoV-2 and time to first COVID-19 outbreak.

Hypothesis: Higher rates of community transmission will result in less time between school opening and first outbreak.

Methods

Study Design

The Washington State Department of Health (DOH) School Outbreak Assessment of Policies and Practices (SOAPP) survey is a retrospective survey designed to learn about school outbreaks and to assess the effectiveness of certain COVID-19 mitigation measures in reducing transmission in the K-12 school setting.⁵ Interviewers from DOH and the University of Washington Student Epidemic Action Leaders (SEAL) team asked school administrators and nurses about COVID-19 outbreaks that had occurred on their campuses. School learning modalities were identified by the school point of contact and confirmed during the SOAPP survey along with more in-depth questions about school operations at the time of the outbreak. For this analysis, learning modality definition was aligned with the Washington State Office of the Superintendent (OSPI) as follows:

1. Traditional in-person: All students have in-person instruction 5 days/week. A remote option may be available for families that want to opt-out of in-person instruction.
2. Hybrid: All students receive some level of in-person instruction, though this may not take place every school day. This can include part day or every other day in person

instruction, alternating with remote learning. A remote option may be available for families that want to opt-out of in-person instruction.

3. Remote with exceptions: Almost all students are remote. Exceptions are made for students with special needs who may spend some time in-person. Some schools may allow teachers to teach online classes from campus.
4. 100% remote: All students are remote. Some schools may allow teachers to teach online classes from campus.

Time 0 is defined as the date when a school opened in a certain learning modality (e.g. 100% remote, remote with exceptions, hybrid, traditional in-person). Time to outbreak in days is established by comparing the date the school opened and the date of the first case in the outbreak. Key covariates include COVID-19 community level transmission at the time of the outbreak, size of outbreak, and who was involved in the outbreak (staff, students, or both). This information will be included in the SOAPP dataset and gathered through surveillance reports of cases.

Study Setting

This research took place remotely in order to ensure the safety and wellbeing of those involved. This study was conducted in partnership between the UW and the Washington State Department of Health Office of Communicable Disease Epidemiology whose staff organized and collected the SOAPP survey data.

Study Population

This study used school-level data. The definition of a school outbreak is as follows: two or more COVID-19 infections with an epidemiologic link to the school and symptom onset or positive COVID-19 tests within 14 days. All school outbreaks included in the analysis met this definition. There were 54 SOAPP interviews completed by the end of March that are included in this study.

Data Collection

This project utilized data from the School Outbreak Assessment of Policies and Practices (SOAPP) survey. Once a school outbreak was identified, as defined above, the COVID-19 Outbreak Response in Non-healthcare Congregate Settings Program at the Washington State Department of Health worked with local health jurisdictions to gather basic information about the outbreak. After a point of contact for the school was established, both DOH staff and University of Washington students were assigned schools to interview. Once the school was contacted, they were provided a copy of the SOAPP survey so that they could gather responses to the detailed questions asked in the survey. Then the point of contact was interviewed remotely to go over their SOAPP survey responses and clarify any missing information or questions requiring clarification. All of the survey responses were recorded in a REDCap database for further analysis.

Statistical Analyses

Descriptive analyses were conducted to better understand key characteristics of COVID-19 outbreaks in K-12 schools by learning modalities. A time-to-event analysis was conducted in order to compare the time to the first outbreak between different learning modalities. All variables used were included in the SOAPP survey data. The Cox Proportional model was utilized to conduct the time to event analysis. Time to outbreak was compared between outbreaks in 100% remote, remote with exceptions, hybrid, and traditional in-person settings. No covariates were used in the model due to the exploratory nature of this study and small sample size. Secondary analyses included the level of community transmission at time of outbreak. Another time to event analysis was conducted to compare the time to first outbreak between different levels of community transmission. Community level transmission was calculated as an average rate over the two weeks prior to the school outbreak. All statistical analyses were performed in R version 4.0.3 (2020-10-10).

Study Power

Power calculations indicated that a sample size of 143 schools would be needed to detect a 40% difference in hazard ratios between learning modalities with a 95% confidence interval and 20% margin of error. However, it is important to note that even though the ideal number of school interviews was not obtained for the current study, the analysis will still be useful in describing school outbreaks in Washington and has the potential to aid in providing guidance to schools about possible reopening in the fall.

Results

After excluding seven outbreaks with unknown key variables (including start date in learning modality, outbreak date, transmission rate, and learning modality), there were 54 school outbreaks included in the study. Due to the limited sample size, it was difficult to discern patterns when broken down by learning modality, especially for full-remote schools as there are only 3 schools that fall in this category (Table 1). This data suggests that schools operating in a full remote with exceptions model have more outbreaks among staff when compared to full in person or hybrid learning models (Table 1). It also seems that most of the full in person schools are private schools, while other models are more likely to be public schools (Table 1).

A Kaplan-Meier curve broken down by learning modality was done as an exploratory analysis (Figure 1). This graph suggests that full in person models may have slightly better time to event outcomes when compared to the other models (Figure 1). The line for full remote schools cannot reasonably be interpreted due to only 3 schools falling in this category. Median number of days to outbreak were calculated for each learning modality and level of community transmission. Full in person schools had the longest time to outbreak of 72 days, while hybrid schools had the shortest time to outbreak of 48 days (Table 2, Figure 2). Community transmission in categories of low, medium and high had 58, 48, and 64 days to outbreak respectively (Table 3, Figure 3).

The time-to-event analysis for the first aim proved insignificant. The Cox Proportional Hazards model flagged a hybrid learning modality to be significant with a p-value of 0.006.

However, this model violated the proportional hazards assumption of the model and thus cannot be interpreted.

Secondary analysis included community transmission level as a covariate in the Cox Proportional Hazards model. This model met all assumptions and flagged hybrid learning modality and low transmission rate as significant. The p-value for hybrid learning modality was 0.008 with a hazard ratio of 4.46 (95% CI: 1.86, 10.70), indicating a strong relationship between a hybrid learning modality and increased risk of an outbreak. Holding community transmission constant, a hybrid learning modality was associated with shorter time-to-event outcomes. This was similar to what was observed with the Kaplan-Meier estimate. The p-value for low transmission rate was 0.0015 with a hazard ratio of 3.73 (95% CI: 1.65, 8.40), indicating a strong relationship between a low transmission rate and shorter time to outbreak. Holding learning modality constant, a low transmission rate was associated with poorer time to event outcomes.

Discussion

Although the primary analyses proved statistically insignificant, there are a few takeaways from the secondary aim. The analyses suggest that a hybrid learning modality and low COVID-19 community transmission rate are associated with a shorter time to outbreak. Although a hybrid learning model and low transmission rate were found to be statistically significant, that does not mean that they are meaningfully different. The median time to outbreak for a hybrid learning model was 48 days compared to 72 days for a full in person model (Table 2, Figure 2). A difference of 24 days might not be meaningful for a school district to warrant a change in learning modality to potentially delay an outbreak. The median time to outbreak for low community transmission was 58 days compared to 64 days for high community transmission (Table 3, Figure 3). Again, this might not be meaningfully different and reason to close a school based on community level transmission. Despite the small sample size for this

study, there is still an opportunity to try to characterize the relationship between school outbreaks, learning modality and community transmission.

These findings contradict common beliefs about outbreaks in schools. It is thought that higher rates of community transmission of COVID-19 results in a greater chance of COVID-19 being introduced in schools and causing an outbreak.³ In the context of the current study, it is possible that longer times to outbreak were observed for full in person schools because they were more likely to be private schools with smaller class sizes that opened earlier in the school year when community transmission was lower. There could also be potential impacts on exposure settings for families with children in a hybrid learning model. If a child attends school in person for part of the week, they may also be attending daycare for the time that they are not in person. This would add another potential site of exposure.

There are also many other factors that can influence COVID-19 outbreaks in schools that were not included as a part of this study that should be explored further. For example, schools that require mask use had a 37% lower incidence of COVID-19.⁶ Masking was not considered as a part of this study. Although all Washington schools had some policy about mask use, it is possible that policy around mask use differs from practice. In addition, schools that improved ventilation had a 39% lower incidence of COVID-19.⁶ Continuing to employ strong mitigation measures in schools can help ensure that students can continue to attend in person instruction. School based COVID-19 testing might be one prevention strategy that schools might want to consider.⁷

Limitations

There was a strong limitation in the lack of available data, and the sample size for this study was not sufficient to draw any meaningful conclusions. Also, due to increased demand on school administrators, there could be a higher number of schools lost to follow up if the school point of contact does not have the bandwidth to participate in the SOAPP survey. This could result in selection bias if demand on school administrators is associated with certain learning

modalities or levels of COVID-19 community transmission. School point of contact reports on school policies and practices are also subject to recall and social desirability bias. Respondents may be more inclined to report a higher rate of compliance with school policies. There is also the possibility of data entry error on behalf of the interviewers.

Conclusions

More evidence-based guidance will likely be needed to aid schools in developing a plan to remain open for the 2021-2022 school year, as well as preparedness planning for future pandemics. This study suggests that learning modality and the level of community transmission of COVID-19 could play a role in the time between a school opening and an outbreak occurring. However, more research needs to be conducted to draw any real conclusions.

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Table 1: Descriptive Characteristics of COVID-19 Outbreaks in Washington State K-12 Schools by Learning Modality, School Outbreak Assessment of Policies and Practices (SOAPP) 2020 - 2021.

Characteristic	Full In-Person (n = 14)		Hybrid (n = 19)		Full Remote* (n = 3)		Remote with Exceptions (n = 18)	
	n	%	n	%	n	%	n	%
Size of Outbreak								
<5 cases	9	64.29	12	63.16	2	-	15	83.33
5-10 cases	2	14.29	2	10.53	0	-	0	0.00
>10 cases	3	21.43	5	26.32	1	-	3	16.67
Persons in Outbreak								
Staff	3	23.08	6	35.29	1	-	14	77.78
Students	5	38.46	3	17.65	0	-	2	11.11
Both	5	38.46	8	47.06	1	-	2	11.11
Missing**	1	-	2	-	1	-	0	-
Facility Type								
K-12 Charter School	0	0.00	1	5.26	0	-	0	0.00
K-12 Private School	8	57.14	1	5.26	0	-	0	0.00
K-12 Public School	4	28.57	17	89.47	3	-	18	100.00
Other	2	14.28	0	0.00	0	-	0	0.00
Grade Served***								
Pre-K	8	57.14	4	21.05	0	-	1	5.55
Elementary	13	92.86	14	73.68	1	-	3	16.67
Middle	8	57.14	6	31.58	1	-	4	22.22
High	6	42.86	2	10.53	1	-	11	61.11
Community Transmission****								
Low	6	42.86	4	21.05	3	-	5	27.78
Medium	2	14.29	6	31.58	0	-	5	27.78

High 6 42.86 9 47.37 0 - 8 34.44

*Column percentages are not included for full-remote schools due to a small sample size.

**Missing values are not included in the column percentages.

***Schools may fall into more than one category. Column percentages for grades served will not add to 100%.

****Community transmission rates are defined as the number of cases per 100,000 persons over the two weeks prior to the outbreak reference date. The cutoff point for each category is as follows: (Low) Less than 200 cases per 100,000 (Medium) Between 200 and 400 cases per 100,000 (High) 400 or more cases per 100,000.

Note: Column percentages may not add to 100% due to rounding.

Figure 1: Kaplan Meier Time to Outbreak in Washington K-12 Schools by Learning Modality, School Outbreak Assessment of Policies and Practices (SOAPP) 2020 - 2021.

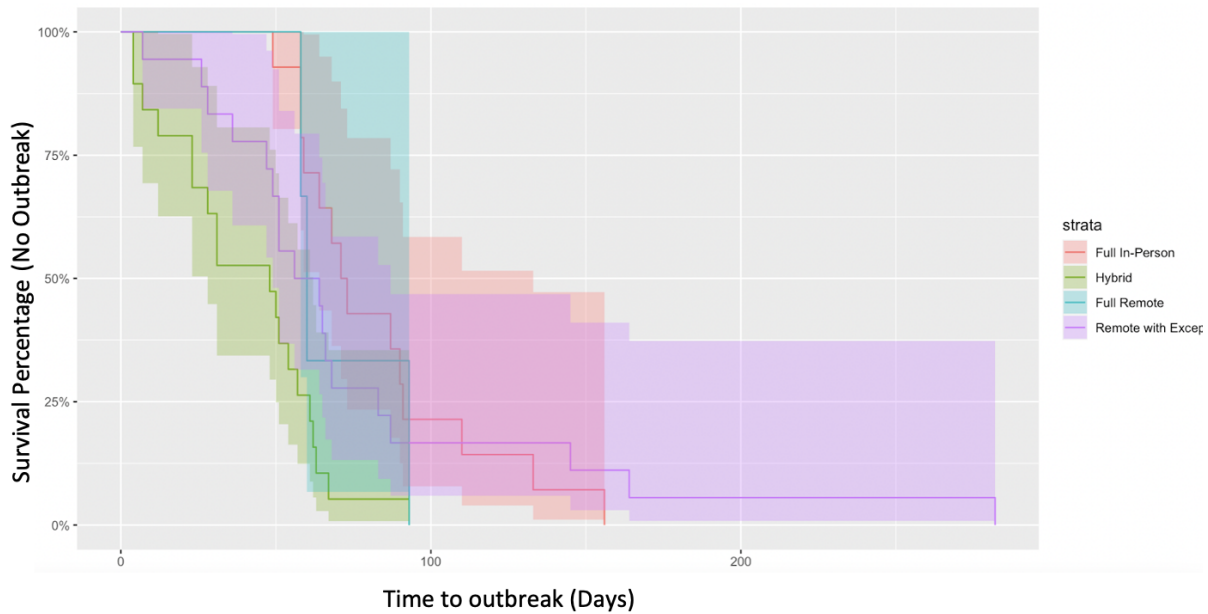


Table 2: Median Time to Outbreak in Washington K-12 Schools by Learning Modality, School Outbreak Assessment of Policies and Practices (SOAPP) 2020 - 2021.

	Learning Modality			
	Full In-Person (n = 14)	Hybrid (n = 19)	Full Remote* (n = 3)	Remote with Exceptions (n = 18)
Median time to outbreak (days)	72	48	60	60

*Small sample size for full remote, median time to outbreak is not a reliable estimate.

Figure 2: Time to Outbreak in Washington K-12 Schools by Learning Modality, School Outbreak Assessment of Policies and Practices (SOAPP) 2020 - 2021.

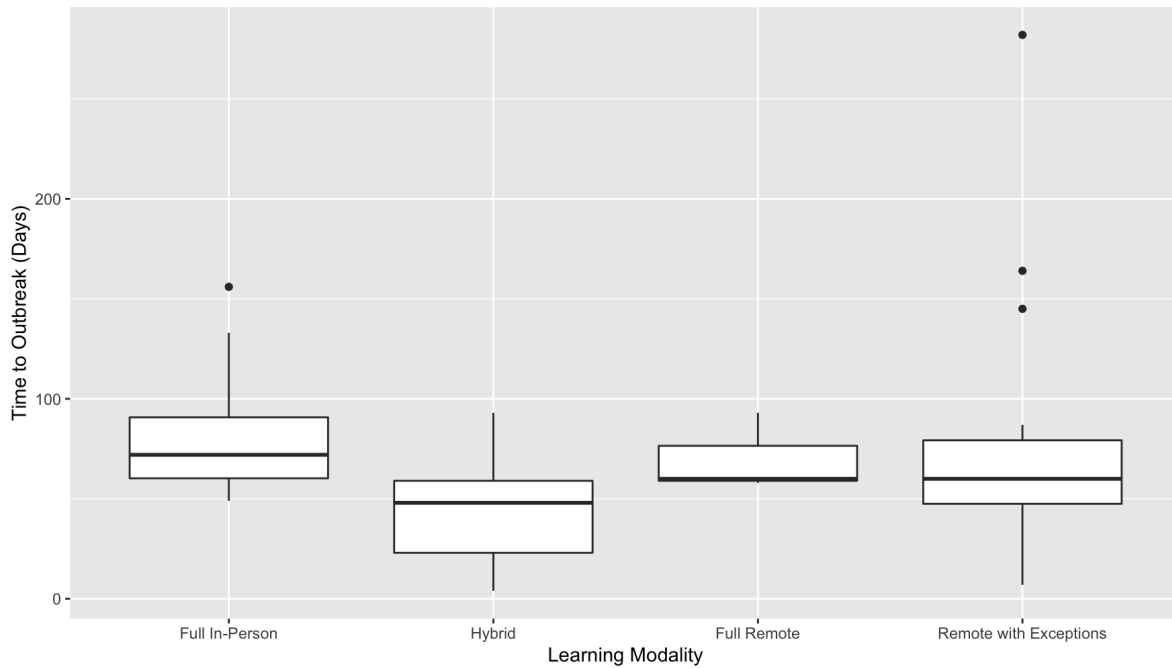
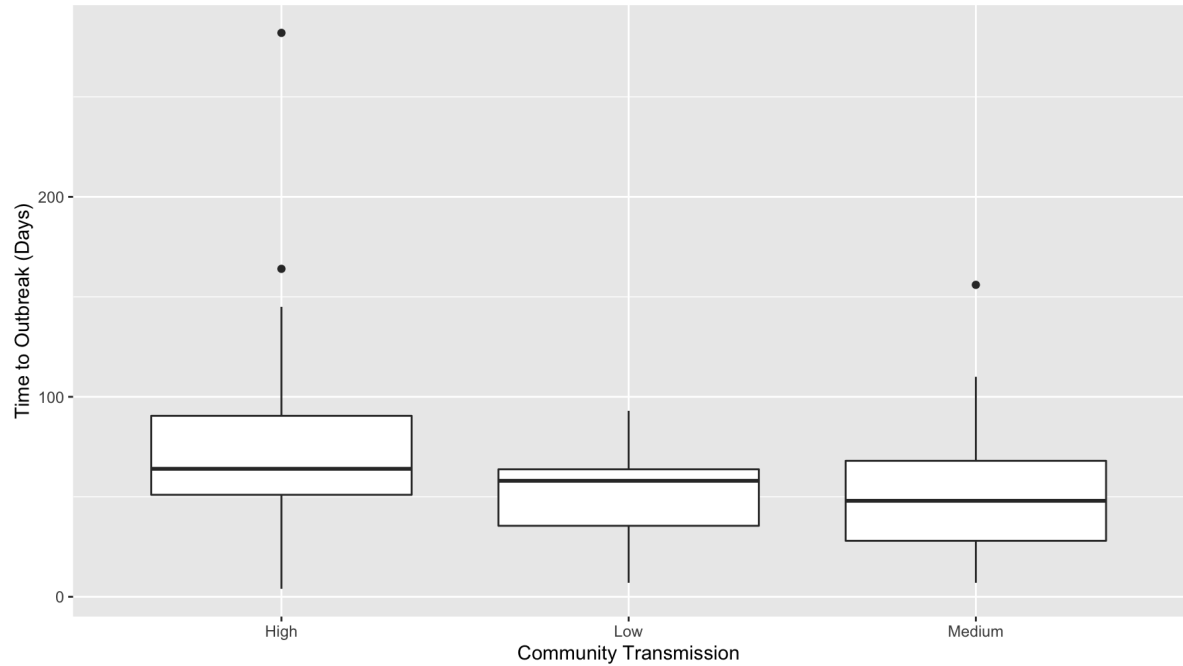


Table 3: Median Time to Outbreak in Washington K-12 Schools by Community Transmission, School Outbreak Assessment of Policies and Practices (SOAPP) 2020 - 2021.

	Community Transmission*		
	Low (n =)	Medium (n =)	High (n =)
Median time to outbreak (days)	58	48	64

*Community transmission rates are defined as the number of cases per 100,000 persons over the two weeks prior to the outbreak reference date. The cutoff point for each category is as follows: (Low) Less than 200 cases per 100,000 (Medium) Between 200 and 400 cases per 100,000 (High) 400 or more cases per 100,000. Note: Column percentages may not add to 100% due to rounding.

Figure 3: Time to Outbreak in Washington K-12 Schools by Community Level Transmission*, School Outbreak Assessment of Policies and Practices (SOAPP) 2020 - 2021.



*Community transmission rates are defined as the number of cases per 100,000 persons over the two weeks prior to the outbreak reference date. The cutoff point for each category is as follows: (Low) Less than 200 cases per 100,000 (Medium) Between 200 and 400 cases per 100,000 (High) 400 or more cases per 100,000. Note: Column percentages may not add to 100% due to rounding.