

Utilizing Wastewater Surveillance to Examine SARS-CoV-2 RNA Presence in Wastewater During a Period of Mass Vaccination on a College Campus



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Introduction

- Wastewater-based epidemiology (WBE) has guided public health decisions at institutions such as universities throughout the COVID-19 pandemic (Bivins & Bibby, 2021).
- Individuals infected with COVID-19 shed the virus and its genetic material, SARS-CoV-2 RNA, which is detectable in bodily fluids (Larsen & Wigginton, 2020).
- Once the virus is shed, it enters the wastewater system. (Centers for Disease Control and Prevention [CDC], 2021).
- RT-ddPCR quantifies and detects SARS-CoV-2 RNA in wastewater samples by targeting the nucleocapsid (N) gene using N1 and N2 primer and probes (Babiker et al., 2020).

Purpose

Examine trends of SARS-CoV-2 RNA signal in wastewater during a period of mass vaccination at Grand Valley State University (GVSU).

Hypothesis

- During a mass vaccination program, there would be a decrease in the SARS-CoV-2 RNA in wastewater and a decrease in COVID-19 cases. Additionally, there would be a positive correlation between SARS-CoV-2 RNA gene copies at sampling sites and COVID-19 7-day average cases.

Methods

- This is a secondary data analysis and included data from April 5, 2021 to December 16, 2021.
- Population: Over 28,000 faculty, staff, and students at GVSU.
- Publicly available deidentified data from GVSU's COVID-19 data dashboard was used to collect COVID-19 7-day case averages and vaccination rates of faculty, staff, and students.
- Extracted and purified viral RNA from each sample was assayed for COVID-19 biomarkers using the Bio-Rad QX200 ddPCR System to target the N gene of SARS-CoV-2.
- Statistical analysis was conducted using SAS version 9.4. A Mann-Whitney U test, Spearman correlation coefficient (ρ), and Fisher's exact test assessed the quantitative comparison and correlations of wastewater data, COVID-19 cases, and vaccination rates.

Table 1
Wastewater Sample Locations

Location Code	Sample Site	Campus	Collection Sites Contributing to Sample	Estimated Population
G1	North Campus 1	Albion	Student Living Centers (7); Hutton Hooper Learning and Living Center; Fox, Oak, Maple, Robinson, Copeland, and Kester	738
G2	Laker Village	Albion	Laker Village Apartments (90); Laker Village Includes 30 apartment buildings	560
G3	Wood Living Center	Albion	Student Living Centers (8); Haddock, Johnson, Oak, Wood, Frey, and North C Living Centers	615
G4	South II	Albion	Student Living Centers (5); South C, South D, South E, Murray, Francis, Westcott, Strawn, Kromer, and Mackenzie	825
G5	Norwester Living Center	Albion	Student Living Centers (6); Norwester, West, Norwester West, Norwester Annex College, Cedar Rowland	367
G6	Winter Hall	Grand Rapids	Grand Rapids Student Living Center (5); Winter Hall	450
G7	Sechcia Hall	Grand Rapids	Student Living Center (5); Sechcia Hall	390
G8	North Campus 2	Albion	Student Living Centers (8); Pickard, Sedman, Swanson, Safford, Kolodenski, Hills, Frey, and DeVito	542

Results

Sample Characteristics

- Site G1-G5: 23 samples total
- Site G8: Sampling began in September
- Sites G6 and G7: Consistent sampling for April only

Vaccination Rates

- SARS-CoV-2 gene concentration was negatively correlated with vaccination rates at all sampling sites, excluding site G8.
- A significant positive correlation was observed between vaccination rates and COVID-19 7-day case averages.

Same-Day

- SARS-CoV-2 gene concentration was positively correlated with GVSU COVID-19 7-day case averages for all eight sampling sites.
- Significant correlations were seen for sites G3 and G4.

Figure 1
GVSU Sampling Site Graphs Displaying Wastewater Data (N Gene Copies/100 mL) and COVID-19 Cases (7-Day Average) Over Dates of Collection

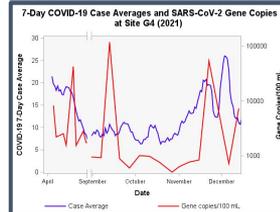
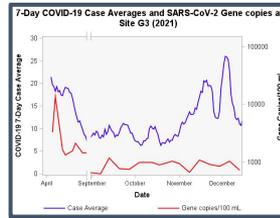


Table 2

Spearman Correlations and Descriptive Statistics Among Wastewater Site Variables (N Gene Copies/100 mL), COVID-19 Cases (7-Day Average), and % Vaccinated

Variable	COVID-19 7-Day Case Average	Faculty/Staff Vaccination Rate (%)	Student Vaccination Rate (%)
COVID-19 Case Average	-		
Staff Vaccination Rate (%)	0.31***	-	
Student Vaccination Rate (%)	0.31***	1.0***	-
Site G1 (N gene copies/100 mL)	0.30	-0.23	-0.23
Site G2 (N gene copies/100 mL)	0.41	-0.61**	-0.61**
Site G3 (N gene copies/100 mL)	0.42*	-0.69***	-0.69***
Site G4 (N gene copies/100 mL)	0.41*	-0.33	-0.32
Site G5 (N gene copies/100 mL)	0.38	-0.55**	-0.55**
Site G6 (N gene copies/100 mL)	0.34	-0.60**	-0.60**
Site G7 (N gene copies/100 mL)	0.35	-0.38	-0.39
Site G8 (N gene copies/100 mL)	0.08	0.03	0.02

*p < .05. **p < .01. ***p < .001

Figure 2
Wastewater Sampling Map at GVSU for Albion and Grand Rapids campus.

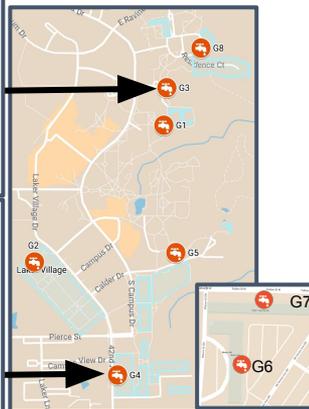
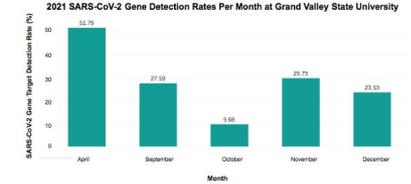


Figure 3



There was a statistically significant decrease in the rate of detection from April 2021 to September 2021 ($p = .04$) and from April 2021 to October 2021 ($p < .001$).

Discussion and Conclusions

- As vaccination rates increased, there was a decrease in SARS-CoV-2 RNA signal in wastewater.
- Faculty, staff, and student vaccination rates were positively correlated with COVID-19 seven-day case averages.
- The positive correlation between SARS-CoV-2 RNA signal from wastewater samples and COVID-19 7-day case averages offers wastewater-based epidemiology as a useful tool for detecting trends in COVID-19 cases before and after mass vaccination.

Public Health Implications

- Wastewater-based epidemiology can be used in neighborhoods or communities that lack access to public health interventions and provide continuous surveillance of high risk locations.
- Surveillance of SARS-CoV-2 RNA signal could guide decision making and early public health interventions.

Future Research

- Viral shedding patterns of infected individuals and those affected by different variants needs additional research.

References

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