Understanding the influence of COVID-19 Testing Intensity on Wastewater-Based Epidemiology through Quantitative Analysis

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Abstract

At the University of Miami (UM), the use of wastewater-based surveillance (WBS) as an epidemiological strategy for monitoring acute respiratory syndrome coronavirus-2 (SARS-CoV-2) has been ongoing since September of 2020. During that time, testing requirements for UM have fluctuated significantly resulting in irregular periods of high and low testing intensity.

This research attempted to quantitatively analyze the impact that testing intensity on the correlations between SARS-CoV-2 levels acquired from WBS and recorded COVID-19 positive cases at UM from January of 2021 to March of 2022. The SARS-CoV-2, recorded positives, and testing data for eight dormitory buildings on UM's Coral Gables campus were analyzed and transformed to assess correlations.

Results show that testing intensity influenced the correlation between SARS-CoV-2 and recorded positive COVID-19 cases. Correlations were weaker during periods of low clinical testing intensity and high levels in wastewater and during periods of high testing intensity and low levels in wastewater. Overall, we recommend that testing intensity parallel SARS-CoV-2 levels in wastewater for more accurate identification of positive COVID-19 cases in a community.

Methods

Wastewater Collection:

- Samples Collected from 8 sites each affiliated with a Residence Hall
- Samples collected from Jan 2021 to March 2022
  - Sampling 2X a week from Sept 2021 to Feb 2022
  - No sampling performed from May 2021 to Aug 2021

Figure 1. Campus map denoting 8 sampling sites.

Sample Normalization:

- Wastewater is variable in source of water and thus source of SARS-CoV-2 so normalizing parameters were introduced:
  - PMMoV
  - B2M

Data Analysis

- Data for each Resident Hall:
  - Log SARS, Log SARS/B2M, Log SARS/PMMoV value for each sampling day
  - Number of COVID-19 tests performed and number of positives per day
  - Z-Score computed for Log SARS parameters and number of daily tests performed $Z = \frac{x - \mu}{\sigma}$
- 3 Week Averages created for all SARS parameters
  - Sampling values were averaged with any values 7 days before and after
- 21 Day Averages created for Daily Tests and Daily Positives data
  - Values were averaged with any values in the 10 days before or after
- 21 Day Average for Positives was regressed against each SARS parameter within different limiting time frames to assess the impact testing intensity has on correlational strength between SARS levels and recorded positives
  - 21 Day Average Test ≥ 3
  - 21 Day Average Test ≥ 10
  - Matching Z-score signs (positive or negative)

Results

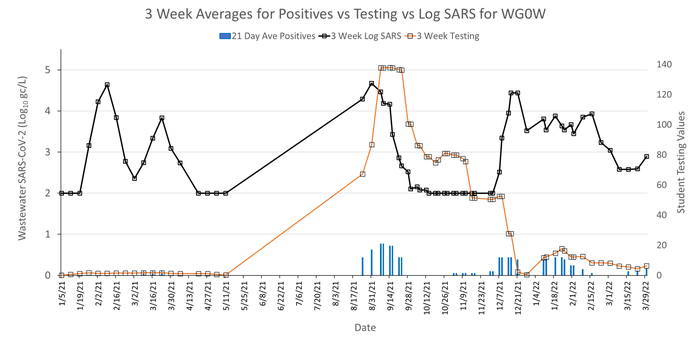
Table 1. Pearson correlation coefficients (R) by sampling site for all 21-day average positives vs differing SARS variables .

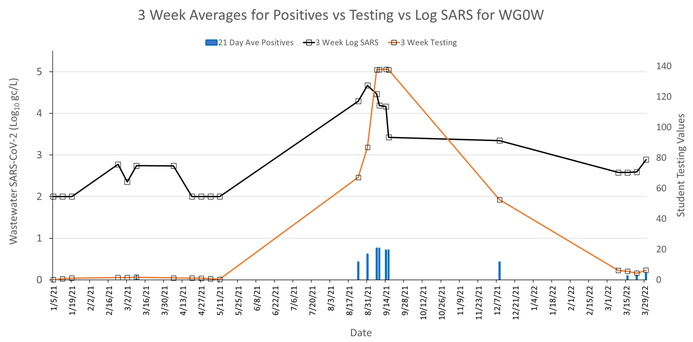
	3 Week Log SARS	3 Week Log (SARS/B2M)	3 Week Log (SARS/PMMoV)
WG0Hm			
All Sampling	0.43	0.31	0.43
Testing ≥ 3	0.61	0.49	0.58
Testing ≥ 10	0.88	0.66	0.90
Z-Score Matching	0.94	0.87	0.69
WG0Hp			
All Sampling	0.53	0.56	0.41
Testing ≥ 3	0.70	0.75	0.55
Testing ≥ 10	0.65	0.70	0.46
Z-Score Matching	0.82	0.86	0.93
WG0R			
All Sampling	0.67	0.54	0.40
Testing ≥ 3	0.86	0.83	0.70
Testing ≥ 10	0.92	0.91	0.77
Z-Score Matching	0.88	0.83	0.68
WG0W			
All Sampling	0.63	0.35	0.53
Testing ≥ 3	0.78	0.65	0.63
Testing ≥ 10	0.85	0.68	0.63
Z-Score Matching	0.91	0.87	0.68
WG0V			
All Sampling	0.73	0.71	0.75
Testing ≥ 3	0.73	0.71	0.75
Testing ≥ 10	0.78	0.75	0.78
Z-Score Matching	0.87	0.79	0.77
WG0L			
All Sampling	0.60	0.62	0.60
Testing ≥ 3	0.70	0.75	0.64
Testing ≥ 10	0.85	0.87	0.81
Z-Score Matching	0.92	0.91	0.86
WG0N			
All Sampling	0.27	0.12*	0.05*
Testing ≥ 3	0.84	0.69	0.75
Testing ≥ 10	0.85	0.67	0.78
Z-Score Matching	0.72	0.63	0.61
WG0P			
All Sampling	0.46	0.43	0.29
Testing ≥ 3	0.46	0.44	0.29
Testing ≥ 10	0.83	0.86	0.74
Z-Score Matching	0.87	0.86	0.76*

Notes: All correlations are significant ($p<0.05$) except those identified with a "*" symbol. All values rounded to hundredths place.

Results

Figure 2. Graphical interpretation of data set for site WG0W prior to any data transformation (above) and after Z-Score transformation (below).





Conclusions

- Testing intensity did have an impact on the correlative strength between SARS-CoV-2 levels acquired from WBS and recorded COVID-19 positive cases at UM from Jan 2021 to March 2022.
- SARS-CoV-2 levels most effective as predictive indicators of positive COVID-19 cases when testing efforts mirror SARS-CoV-2 levels. In other words, as SARS-CoV-2 levels increase, testing intensity should increase. When SARS-CoV-2 levels decrease, testing intensity should decrease.
- Testing that was too minimal yielded correlations with significantly weaker strength and testing efforts that were too excessive did not yield stronger correlations.

Future Directions

- Continue weekly monitoring of SARS-CoV-2 RNA levels at the University of Miami, hospitals and wastewater treatment plants
- Analysis of wastewater for SARS-CoV-2 RNA expanded to a set of Miami grade schools
- Utilize sampling and data management systems to monitor alternative organisms or viruses of interest

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