# Correlation Between Wastewater Surveillance Signals and Emergency Department Visits for Respiratory Viruses: A Multi-Pathogen Analysis

Heidi Schmidt, MPH, Dan Drociuk, MT, Julia Studer, MPH
Surveillance and Epidemiology Practice Unit, Communicable Disease Epidemiology Section

## Background

- Wastewater surveillance provides valuable insights for monitoring infectious diseases at a population level
- South Carolina established a 23-site wastewater surveillance network monitoring multiple respiratory pathogens
- This study evaluates correlations between wastewater viral activity levels (WVAL) and emergency department (ED) visits for SARS-CoV-2, influenza A, and RSV

## Methodology

- Weekly wastewater samples collected from 23 wastewater treatment plants across South Carolina (September 2024-May 2025)
- Samples processed using Qiagen digital PCR platform by SC Department of Public Health Laboratory (PHL)
- WVAL calculated according to CDC NWSS standardized methodology, which normalizes viral concentrations relative to historical baselines
- ED visit data obtained from SC's ESSENCE syndromic surveillance system (BioSense Platform)
- Pearson (linear) and Spearman (rank-based) correlations calculated for each pathogen
- Time series values transformed to Z-scores (standard deviations from mean) to enable direct comparison between metrics with different scales
- Cross-correlation functions applied to evaluate potential lead/lag patterns (0-4 weeks)

## Acknowledgements

- SCDPH Public Health Laboratory staff for coordinating sample collection and testing
- Participating wastewater utilities across South Carolina
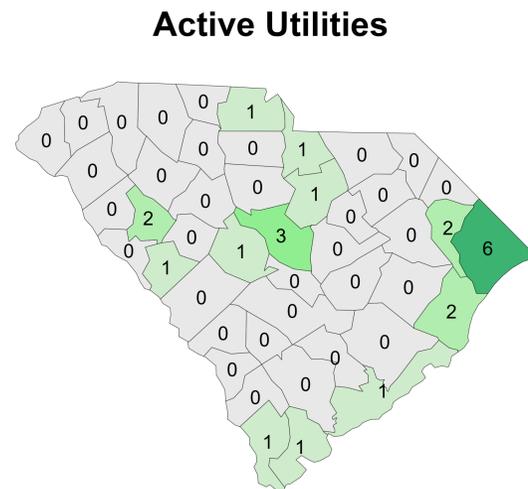- CDC National Wastewater Surveillance System for technical guidance and methodology development

## Active Utilities



Figure 1: South Carolina Wastewater Surveillance Sites by County

## Results

| Pathogen | Pearson r (p-value) | Spearman rs (p-value) | Optimal Lag |
|---|---|---|---|
| COVID-19 | 0.693 (p<0.001) | 0.816 (p<0.001) | 0 weeks |
| Influenza A | 0.968 (p<0.001) | 0.829 (p<0.001) | 0 weeks |
| RSV | 0.727 (p<0.001) | 0.486 (p=0.003) | 1 week lag |

Table 1: Correlation between wastewater viral activity levels and ED visits by pathogen based on analysis of September 2024-May 2025 data (n=35 weeks).
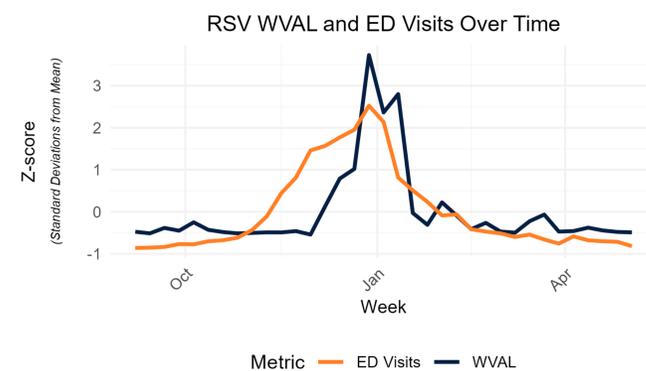


Figure 2: RSV WVAL and ED visits (Z-scores) showing ED visits leading wastewater signals by approximately 1 week.
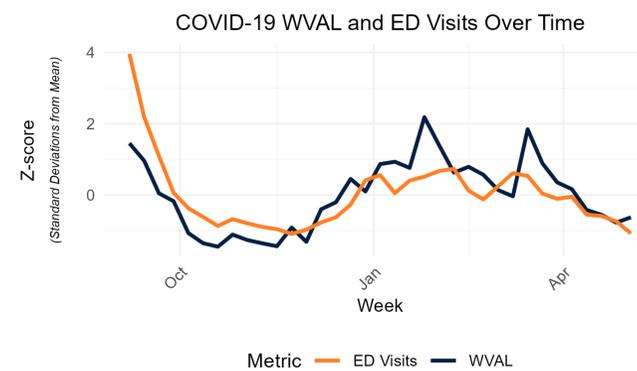


Figure 3: COVID-19 WVAL and ED visits (Z-scores) showing strong correlation (r=0.693) and high rank correlation (rs=0.816) throughout the study period.
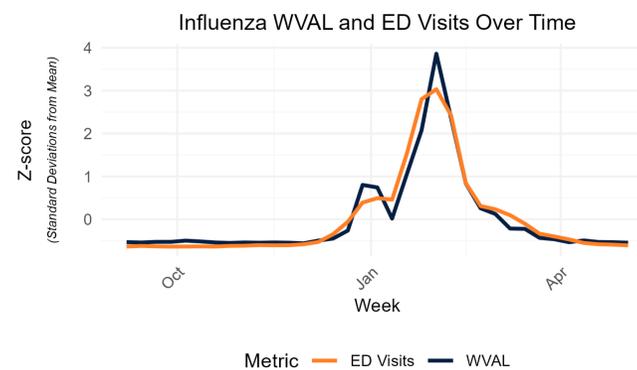


Figure 4: Influenza A WVAL and ED visits (Z-scores) showing very strong correlation (r=0.968) with contemporaneous patterns across the full respiratory season.

## Limitations

- Single respiratory season analysis; long-term patterns require further study
- Geographic representation covers approximately 22% of South Carolina's population; an estimated 40% of population on septic
- Potential influence of clinical testing patterns on ED surveillance data
- Limited ability to account for vaccination effects on healthcare-seeking behavior
- Wastewater captures both symptomatic and asymptomatic infections, while ED data reflects only symptomatic cases seeking care

## Conclusion

- All three respiratory pathogens showed strong to very strong correlations between wastewater signals and ED visits
- Influenza A demonstrated the strongest linear correlation (r=0.968), followed by RSV (r=0.727) and COVID-19 (r=0.693)
- Influenza A showed the strongest rank correlation (rs=0.829), followed by COVID-19 (rs=0.816), indicating consistent patterns even with non-linear relationships
- RSV Spearman correlation (rs=0.486) indicates moderate non-parametric relationship compared to stronger linear correlation
- These findings support wastewater surveillance as a complementary monitoring tool, with pathogen-specific relationship patterns
- Extended dataset (35 weeks) provides comprehensive view of full respiratory season dynamics
- Future work should focus on multi-season analysis to confirm these relationships across different epidemic patterns

## References

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| Contact Information | Heidi Schmidt schmidhl@dph.sc.gov |
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