

# An Ecological Study of the Association Between Ultraviolet B Exposure and COVID-19 Cases

Amanda B. Schreiner,<sup>1,2</sup> Zarena S. Jafry,<sup>2</sup> Mateo Gomez,<sup>3</sup> and Laura Corlin<sup>2,3</sup>

<sup>1</sup>Tufts University School of Arts and Sciences; <sup>2</sup>Tufts University School of Medicine; <sup>3</sup>Tufts University School of Engineering



## Background

- One component of sunlight is Ultraviolet B (UVB).
- UVB can both enter the atmosphere and inactivate viruses.
- UVB may inactivate SARS-CoV-2 in the air or in particles of saliva.
- UVB is required to produce vitamin D, an essential vitamin involved in immunological functioning.
- Increased UVB exposure may be associated with decreased COVID-19 incidence.

## Research Objective

Our objective was to assess whether daily UVB was associated with county-level COVID-19 case counts, accounting for county-level demographics and COVID-19 prevention policies.

## Methods

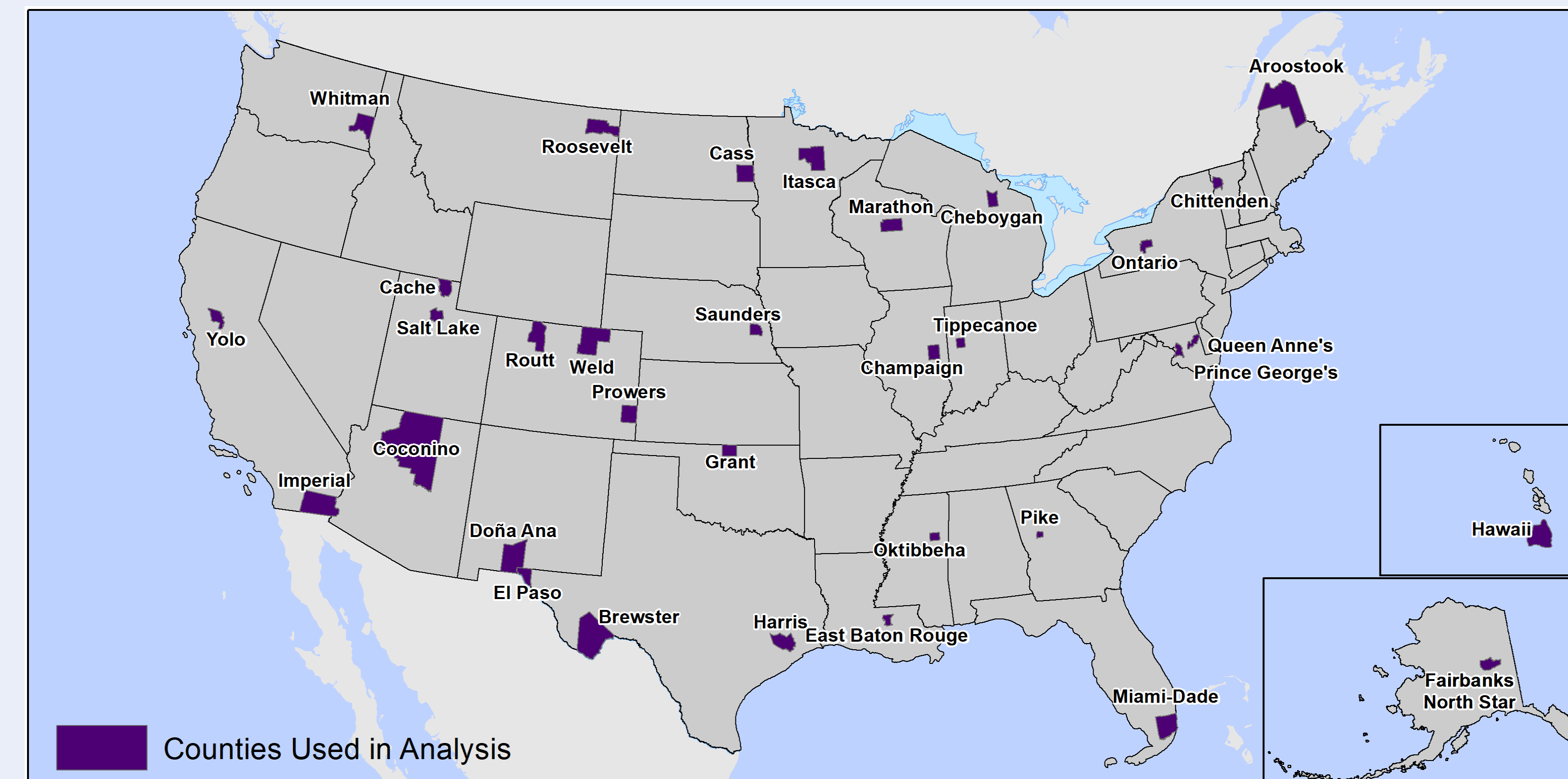
- Study design: Ecologic study
- Exposure data: Daily UVB data (KJ/(m<sup>2</sup> day)) at the county level from the Ultraviolet Radiation Monitoring and Research Program for Agriculture (n = 32 counties; Figure 1)
- Outcome data: Daily COVID-19 case counts (1/22/20-5/23/21) at the county level from the Johns Hopkins database
- Covariate data: County-level data on population size and demographics from the American Community Survey (Table 1), and county- and state-level COVID-19 prevention policies (daily resolution) obtained from state and county government websites
- Statistical modeling: Negative binomial regression (NBR) with 0–28-day lagged UVB, accounting for county-level covariates

Table 1: Average demographic information

UVB (KJ/m <sup>2</sup> day)	Median Household Income	Population Density (people per square mile of land area)	Percent of residents identifying as Non-Hispanic white
20.02	\$52,801.39	339.20	64.37%

Average determined using data from the 32 counties.

Figure 1. Counties included in the study



The counties highlighted had UVB data and were included in the study.

Table 2: Negative binomial regression estimating daily COVID-19 log cases

Variable	$\beta$	p-value	95% confidence interval
UVB (KJ/(m <sup>2</sup> day))	-0.04	<0.001	-0.06, -0.02
Median household income (\$)	1.75E-05	0.364	-2.00E-05, 5.53E-05
Political affiliation (0 = Republican, 1 = Democrat)	0.79	0.132	-0.24, 1.82
Population density (Number of people per square mile of land area)	1.0E-3	<0.001	6.81E-4, 1.74E-3
Percent of residents identifying as Non-Hispanic White (%)	-0.03	<0.001	-0.05, -0.01
Were adults aged 65+ eligible for the vaccine? (Y/N)	-0.37	0.042	-0.73, -0.01
Were masks required indoors? (Y/N)	-0.06	0.834	-0.60, 0.48
Were schools closed? (Y/N)	-0.56	0.041	-1.09, -0.02
Were bars closed? (Y/N)	-0.34	0.224	-0.88, 0.21
Were fitness centers closed? (Y/N)	-0.26	0.153	-0.62, 0.10

## Results

- Each unit increase in daily UVB exposure was significantly associated with an expected 0.04 decrease in the log count of same-day (lag 0) new cases of COVID-19 (Table 2).
- UVB exposure was not significantly associated with COVID-19 case counts 1-28 days later; however, the beta values for 1-28-day lagged UVB were similar to the same-day UVB estimate.

## Strengths and limitations

- Strength: We were able to include COVID-19 policy information, a key set of covariates that has never been included in other COVID-19 environmental epidemiology studies.
- Strength: We included data from 16 months of the pandemic.
- Strength and limitation: We only had sufficient UVB and outcome data to include 32 counties, but these counties represented many parts of the United States at different latitudes and longitudes.
- Limitation: We conducted an ecological study and may have introduced ecological fallacies.

## Conclusions

- We found mixed evidence regarding the association between UVB and COVID-19 cases, accounting for county- and state-level COVID-19 prevention policies and county-level demographic characteristics.
- Future research should be conducted on how the association between UVB exposure and COVID-19 cases varies based on individual characteristics, including accounting for how UVB is processed differently by different population sub-groups.

## Acknowledgements

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