

# INCREASE IN THE SUSCEPTIBILITY TO COVID-19 DURING THE FUNGAL SPORE SEASON AMONG RESIDENTS OF SAN JUAN AND CAGUAS, PUERTO RICO

Xaymara Hernández-González, BS<sup>1,3</sup>; Félix E. Rivera-Mariani, PhD<sup>2,3</sup>; Loyda Méndez, PhD<sup>4</sup>, Benjamín Bolaños-Rosero, PhD<sup>1</sup>

<sup>1</sup>University of Puerto Rico-Medical Sciences Campus, San Juan, Puerto Rico; <sup>2</sup>University of Miami, Miller School of Medicine, Miami, Florida, USA; <sup>3</sup>Respiratory and Immunology Project and Laboratory Research Team, Fort Lauderdale, Florida; <sup>4</sup>University Ana Méndez, Carolina, Puerto Rico

## Abstract

**PURPOSE:** Coronavirus disease 19 (COVID-19) is an emergent respiratory health infectious disease caused by the SARS-CoV-2 virus. Studies have shown outdoor particulates as a risk factor for increased COVID-19 prevalence. The impact outdoor fungal spores, a predominant biological particulate, have on COVID-19 remains unknown. This study evaluated correlations between levels of fungal spores and COVID-19 cases in San Juan and Caguas. In addition, we compared the serum levels of angiotensin-converting enzyme 2 (ACE-2), transmembrane serine protease 2 (TMPRSS2), receptors for SARS-CoV2, and inflammatory cytokines of residents of both municipalities (Caguas = 28; San Juan = 30) during the Season of Fungal Spores (September, October, and November).

**METHODS:** We used a Spearman Correlation Test to evaluate the correlation between COVID-19 cases and levels of fungal spores in 2020. To assess the susceptibility to COVID-19, we measured with ELISA and a multiplex bead-based immunoassay, the levels of peripheral blood ACE-2, TMPRSS-2, and cytokines (IFN-gamma, TNF-alpha, IL-1 beta, IL-1 alpha, IL-5, IL-6, IL-8, IL-10, IL-17, and IL-12 p70).

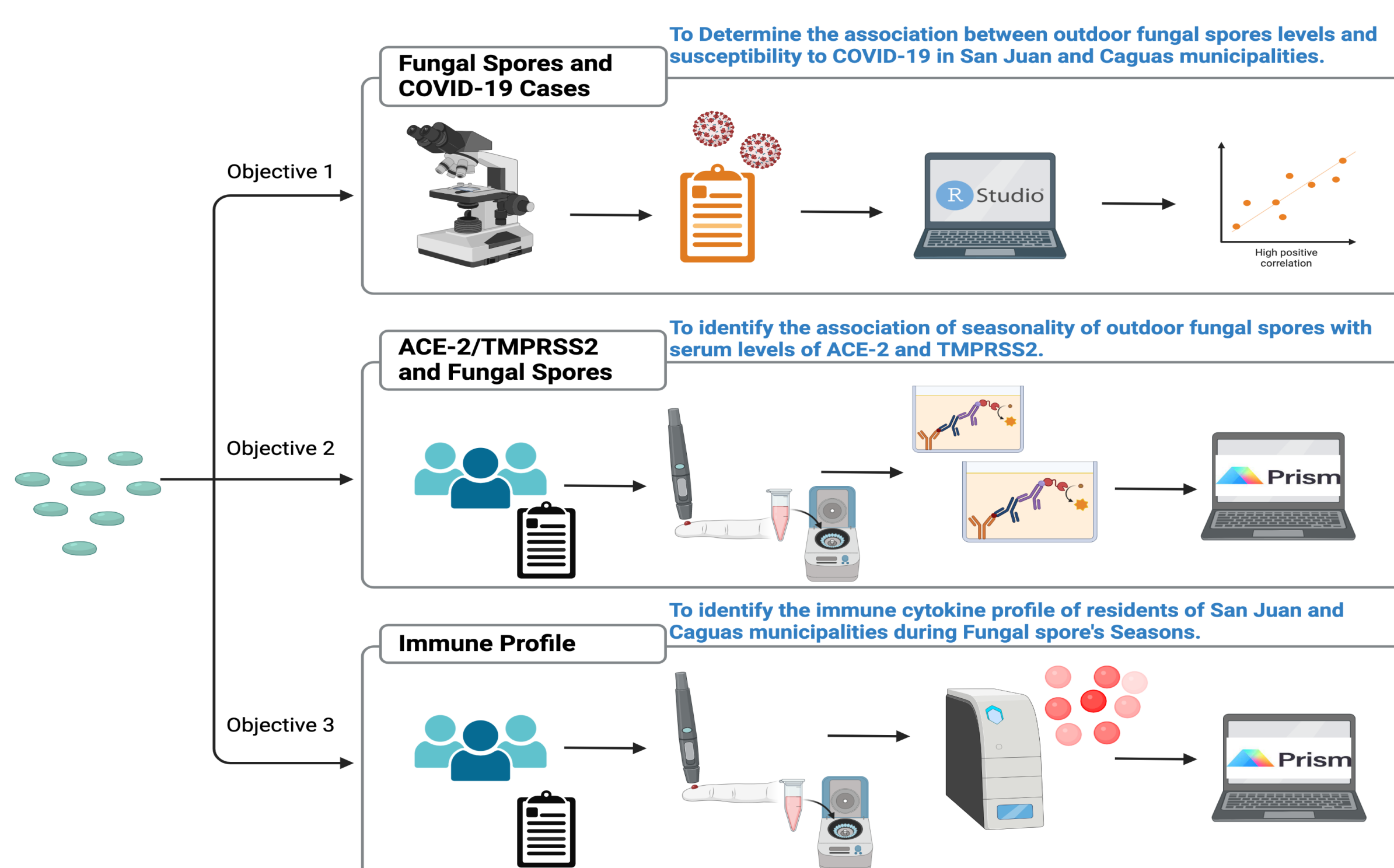
**RESULTS:** COVID-19 cases were positively correlated with Fungal Spores in Caguas (Rho = 0.4620,  $p < 0.001$ ) and San Juan (Rho = 0.3440,  $p < 0.001$ ). We found that levels of ACE-2 were downregulated during the Season of Fungal Spores ( $p < 0.001$ ), and TMPRSS2 was downregulated among Caguas residents ( $p < 0.0001$ ). Also, levels of IL-17 were more elevated among Caguas residents ( $p = 0.020$ ), and IFN-gamma was elevated in San Juan ( $p = 0.069$ ).

**CONCLUSION:** These results suggest that fungal spores may increase susceptibility and morbidity to COVID-19.

## Purpose

Particulate matter has been associated with higher rates of COVID-19 cases; nonetheless, *the environmental impact of particles from biological sources, like fungal spores, has not been studied*. In Puerto Rico, fungal spores predominate during the year but can be found in higher concentrations from September-November (Fungal Spores Season). Moreover, reports from The National Allergy Bureau of the American Academy of Allergy Asthma and Immunology (AAAAI) Caguas Station have found that the municipality has three times more fungal spores than San Juan. Recognizing the potential impact of aeroallergens on respiratory health, this study investigated the role of fungal spores as triggers for susceptibility and morbidity to COVID-19 among Caguas and San Juan residents. The long-term goal of this study is to identify aeroallergens contributing to the prevalence of COVID-19 in Puerto Rico. The overall objectives of this study are 1) to determine serum levels of cellular receptors ACE-2 and TMPRSS2 (during Fungal Spore Season), 2) to determine the serum levels of proinflammatory cytokines, and 3) to investigate associations between daily cases of COVID-19 and daily levels of Fungal Spores. *The central hypothesis of this study is that during the Fungal Spores Season, there would be (i) higher COVID-19 cases and (ii) higher expression of ACE-2 and TMPRSS-2, and (iii) higher levels of cytokines in the serum of the participants from the municipalities of Caguas compared to San Juan.*

## Methods



## Results

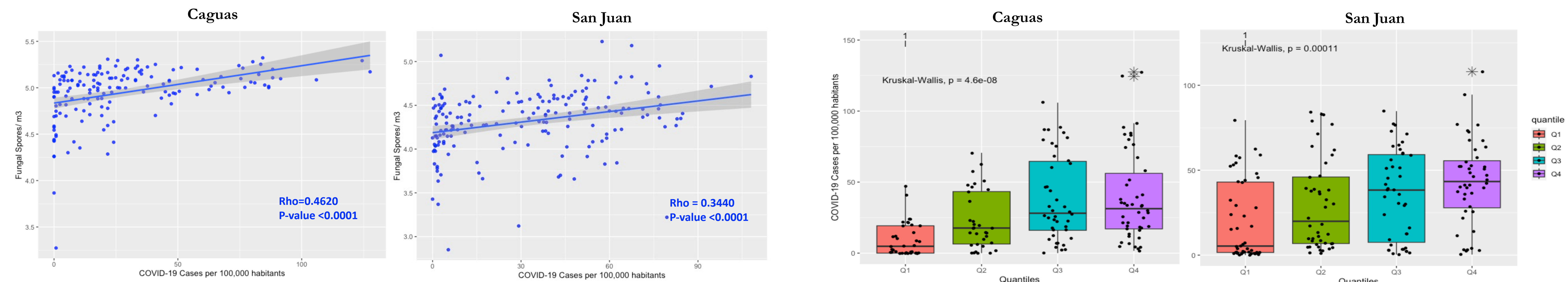
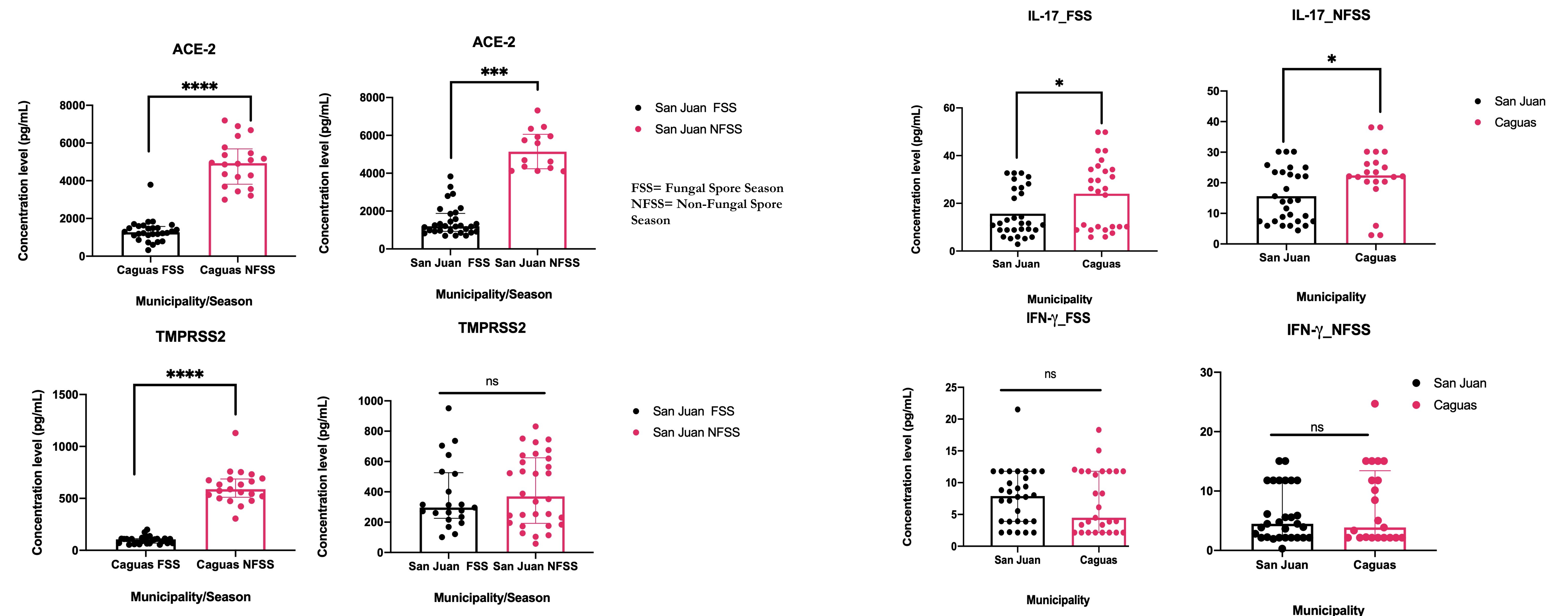


Table 1. Linear Regression Coefficients

Analysis	Estimate	Sdt. Error	T value	R <sup>2</sup>	P value
Caguas Year 2020	39.336	7.236	5.436	0.1584	<0.0001
San Juan Year 2020	23.132	5.423	4.266	0.09322	<0.0001

Table 2. Fungal spores/m<sup>3</sup>

City	Q1	Q2	Q3	Q4	P value
Caguas	67,098	99,138	128,070	210,034	<0.001
San Juan	14,419	23,730	34,945	169,314	<0.001



## Conclusions

- ✓ In 2020, fungal spores correlated with COVID-19 cases in Caguas and San Juan, significantly increasing COVID-19 cases during the Fungal Spore Season.
- ✓ During the Fungal Spore Season, serum concentrations of:
  - ✓ ACE-2 and TMPRSS2 were lower in Caguas and San Juan participants
  - ✓ IL-17 was 2 times higher among Caguas participants reflecting exposure to higher levels of fungal spores.
  - ✓ IFN- $\gamma$  was 1.8 times higher among San Juan participants during the FSS.

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