

Air Pollution and Chronic Rhinosinusitis: Are There Modifiable Risk Factors for Disease Expression?

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Abstract

Introduction: While environmental factors have been studied in asthma/COPD, there have been few investigations examining air pollutants (AP) and chronic rhinosinusitis (CRS). No studies have objectively measured the impact of AP on disease inflammation or symptom severity. This study was conducted to objectively examine the relationship between AP exposure and CRS.

Methods: 246 CRS patients with nasal polyps (CRSwNP) with CT imaging were identified. Air quality testing [particulate matter (PM) and black carbon (BC)] was performed over the span of two years in regions selected by resident zip codes. To quantify inflammation, modified Lund-Mackay (mLM) scores were performed by 3 authors (inter-rater reliability 92.6%, $p < 0.05$). Total steroid dosing was quantified as well as number of functional endoscopic sinus surgeries (FESS).

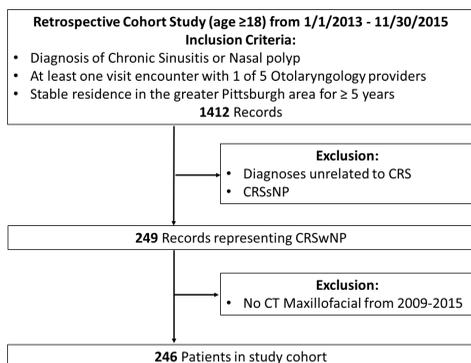
Results: There was a significant difference in mLM staging among those requiring one or more FESS. There were no significant differences in FESS numbers, systemic steroid trials, total steroid dose, or mLM staging by sex ($p > 0.05$). Thirty-two percent underwent ≥ 1 FESS. Mean mLMK score was 26.8. There was significant association between increased particulate matter exposure and undergoing one or more surgeries among females ($p < 0.05$). There was a small positive association ($r = 0.17$) between BC and mLM, (near significant) and between $PM_{2.5}$ and increased number of surgeries, which was at statistical significance ($p = 0.05$).

Conclusions: This pilot study is the first of its kind to objectively measure AP exposure and CRS which suggests a positive correlation may exist between disease severity and AP. Further investigation will include analysis by regional differences, symptom severity, and control comparisons

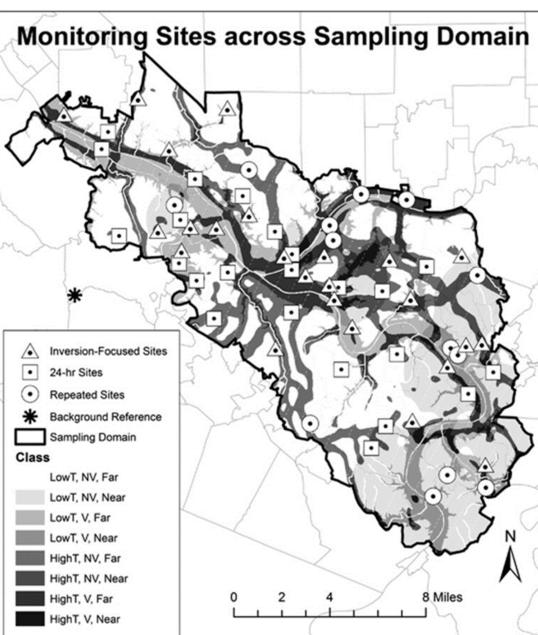
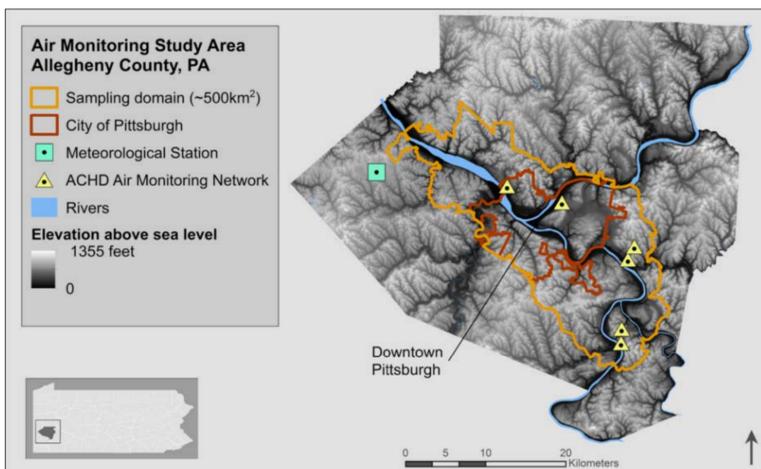
Introduction

- There is an established relationship between CRSwNP and inflammatory lung diseases like asthma.¹⁻³
- Several studies have shown association between PM exposure and asthma/COPD exacerbations and decreased pulmonary function.⁴⁻⁶
- CRSwNP is traditionally understood as a type 2 inflammatory pattern, characterized by high eosinophils, T-helper 2 (Th2) cells, IL-5, IL-4, and IL-13.⁷⁻⁹
- Black carbon, a major component of PM, has been shown to affect bacterial colonization with *Streptococcus pneumoniae* and *Staphylococcus aureus* biofilms that are more complex, thicker, and have increased resistance to antibiotics with BC exposure.¹⁰
- Given these inflammatory and bacterial correlations, it is biologically plausible that air pollutant exposures may impact CRS pathophysiology.

Methods and Materials



Air Monitoring Study Domain. Selection of the study domain aimed to capture large industrial point sources, major roadways, and river valleys across an urban-to-suburban gradient of Allegheny County, PA.

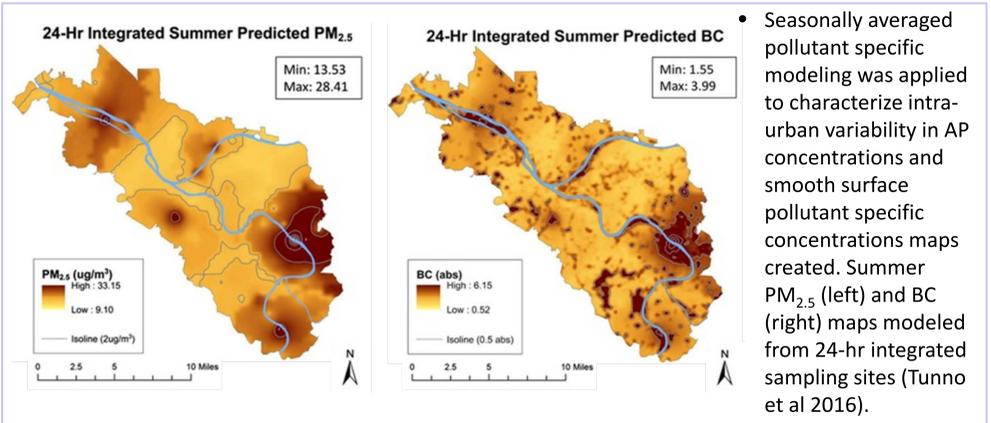


Air Pollution Sampling Methods. Pollution concentrations were measured during summer and winter across 37 air monitoring sites by two methods: inversion-focused (Monday-Friday from 6:00-11:00 AM to capture rush hour variations) or 24-hr (integrated 24-h 7-day sample of 15 min per hour).

- Study results depict pollution data extrapolated from 24hr summer values.

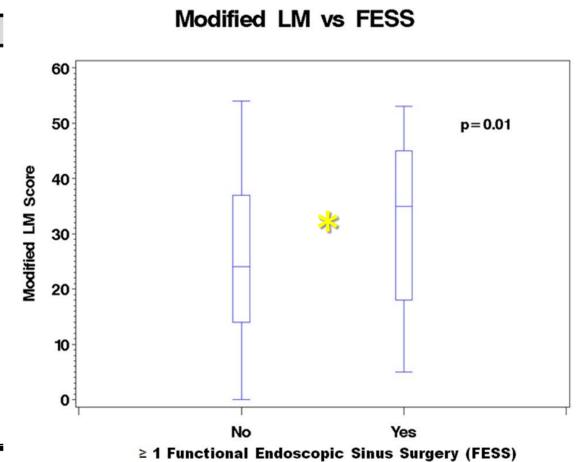
Tunno BJ, Michanowicz DR, Shmool JLC, et al. Spatial variation in inversion-focused vs 24-h integrated samples of PM_{2.5} and black carbon across Pittsburgh, PA. J Expo Sci Environ Epidemiol. 2016 June; 26(4): 365-376.

Results

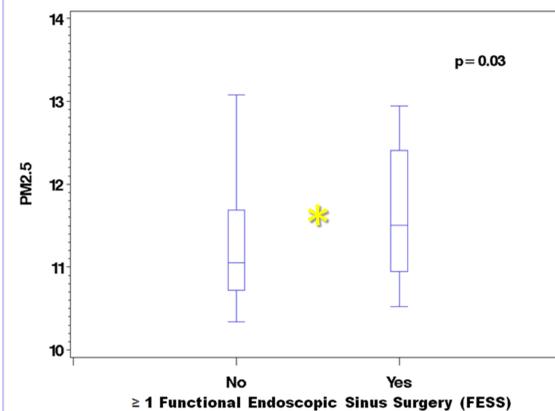


Seasonally averaged pollutant specific modeling was applied to characterize intra-urban variability in AP concentrations and smooth surface pollutant specific concentrations maps created. Summer $PM_{2.5}$ (left) and BC (right) maps modeled from 24-hr integrated sampling sites (Tunno et al 2016).

N = 246	No. (%)
Sex	
Female	112 (46%)
Male	134 (54%)
Current Tobacco Use	
Non-smokers	215 (87%)
Smoker	31 (13%)
Former Tobacco Use	
Never smoked	161 (66%)
Former smoker	85 (34%)
Disease Classification	
CRSwNP only	126 (51%)
CRSwNP and Asthma	80 (34%)
AERD	37 (15%)



Females: Fine Air Particles vs FESS



- Increased Modified LM score is associated with ≥ 1 FESS among all patients ($p < 0.05$).
- Increased $PM_{2.5}$ is associated with ≥ 1 FESS among females ($p < 0.05$).
- No difference in air pollutant exposure by CRS disease presentation (CRSwNP only; vs CRSwNP and Asthma; vs AERD), ($p > 0.05$) results not shown.

Spearman Correlation Coefficients

Prob $> |r|$ under $H_0: \rho = 0$

Sex = Female

	mLM	Steroid (mg)	# Surgeries
Black_Carbon	0.16816 0.0768	0.02033 0.8315	0.10007 0.2960
Fine_Air_Particles	0.08188 0.3911	0.04918 0.6066	0.17948 0.0595

- Correlation of air pollutants and disease severity among females. Small positive association of BC and mLM (near significant). Small positive association of $PM_{2.5}$ and increased number of surgeries, which was at statistical significance.

Discussion

- While the relationship of environmental risk factors has been studied in asthma/COPD, there have been few studies examining the relationship between AP and CRS.
- Existing literature has shown that allergens, fungi, and bacterial superantigens contribute to CRSwNP, but data on the relationship between air quality and CRSwNP is limited.^{1,2}
- This pilot study was the first of its kind to objectively examine the relationship between air pollutant exposure ($PM_{2.5}$ and BC) and CRSwNP presentation.

Conclusions

- There were no differences found between air pollutant exposures and CRSwNP ONLY; CRSwNP and asthma; or Aspirin Exacerbated Respiratory Disease.
- Our findings suggest there may be gender differences in AP exposure and disease presentation:
 - Females were found to have a significant association between increased particulate matter exposure and undergoing one or more FESS ($p < 0.05$).
 - Females demonstrated a small positive association ($r = 0.17$) between BC and mLMK, (near significant) and between $PM_{2.5}$ and one or more FESS ($p = 0.05$).

Contact

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