Air Quality Index and Asthma in California

Do air quality levels and asthma rates in California counties have a statistically significant relationship?

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Background:

AQI Basics for Ozone and Particle Pollution

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

Image 1: AQI index values and explinationn

Note: image from airnow.gov

the severity of the symptoms, asthma ranges from a minor nuisance to a life-threatening condition. The Asthma and Allergy Foundation of America cites that 1 in 13 Americans has asthma (about 8% of adults and 7% of children). The

World Health Organization lists environmental allergens and irritants such as air pollution among the primary known causes of asthma. A 2021paper by Huang et al. concluded that even small reductions in air pollution can reduce childhood asthma outcomes. The AQI is the United States Environmental Protection Agency's method of reporting air quality. The higher the AQI value the higher the level of pollutants and health risks [see Image 1]. This research project aims to see if there is a statistically significant relationship between the number of unhealthy days (AQI >= 151) and asthma rates in the years 2015-2018 at the California county level.

> *"Multiple epidemiologic studies have shown ongoing associations between high levels of air pollution and poor early life lung growth, development of allergic sensitization, development of asthma..." (*Pfeffer et al. 2021)

Data Sources:

- CA 2015-2018 Asthma (chhs.ca.gov)
- EPA 2015-2018 EPA Annual Summary Data (epa.gov)

Methods:

The analysis was conducted in R studio utilizing the packages: dplyr, readxl, gapminder, data.table, gapminder, and ggplot2. The AQI data was national data downloaded by year and included columns such as State, County, Unhealthy Days, and Max AQI. The data was then filtered for only California data and merged with the unhealthy days summed across two-year periods. All rows with NA values were dropped.

The Asthma data was downloaded for the years 2015-2018 with county asthma rates reported for two-year periods and included columns such as County, Years, and Current

Prevalence. The Asthma prevalence data is recorded s a decimal (x/100). All rows with NA values were dropped.

The AQI and Asthma data frames were then combined and all data were grouped by county. Histograms of each layer column were recorded (Days AQI > 150 for 2015-2016, Days AQI > 150 for 2017-2018, Asthma Rate 2015-2016, and Asthma Rate 2017-2018)[see Image 2]. Correlations were run for Days AQI > 150, Asthma Rate, and Years. Finally, regressions were run for each possible interaction between Days AQI > 150, Asthma Rate, and Years. To aid in visualizations heatmaps of California counties were run for Days AQI > 150 and Asthma Rate across both time periods [see Images 4 and 5].

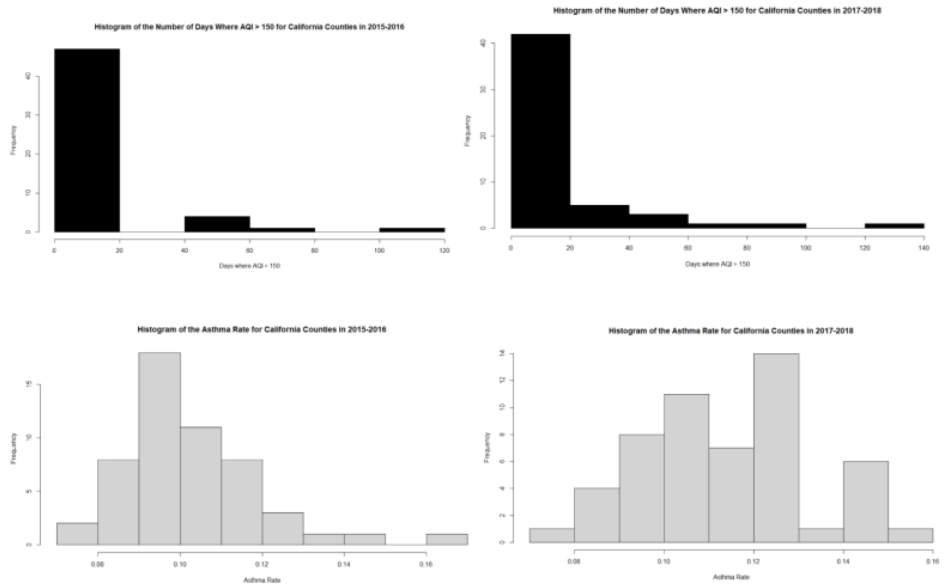

Image 2: Histograms of Asthma an Number of unhealthy AQI days by Years

Results and Conclusions:

Asthma and AQI in this analysis were found to have a negligibly low correlation of a P-value just below 0.3. The only significant regression was for the model y = Asthma Rate in 2015-2016 and X = Days AQI > 150 in 2015-2016 with a P-value of 0.0528. Here The null hypothesis was rejected and we can conclude that there is a statistically significant positive relationship between the two variables. For this time period,

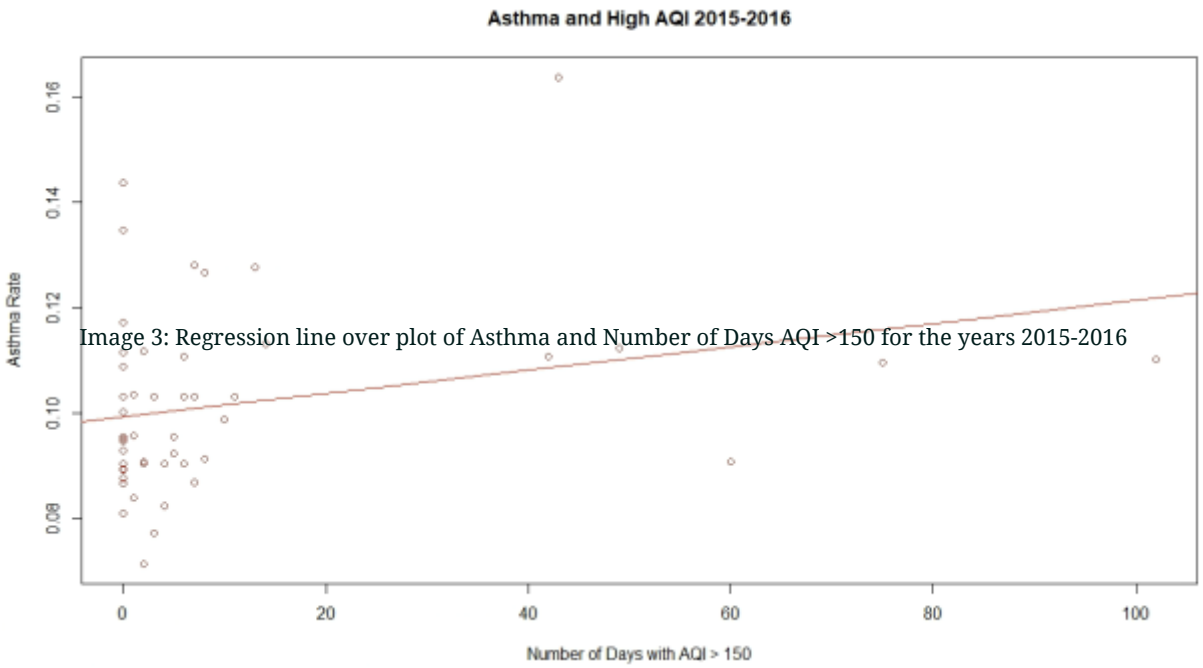

Image 3: Regression line over plot of Asthma and Number of Days AQI >150 for the years 2015-2016

significant relationship between asthma rate and days with AQI >150 in this time period with a p-value of 0.2954. Here we can not reject and null hypothesis and conclude that there is no statistically significant relationship between these two variables.

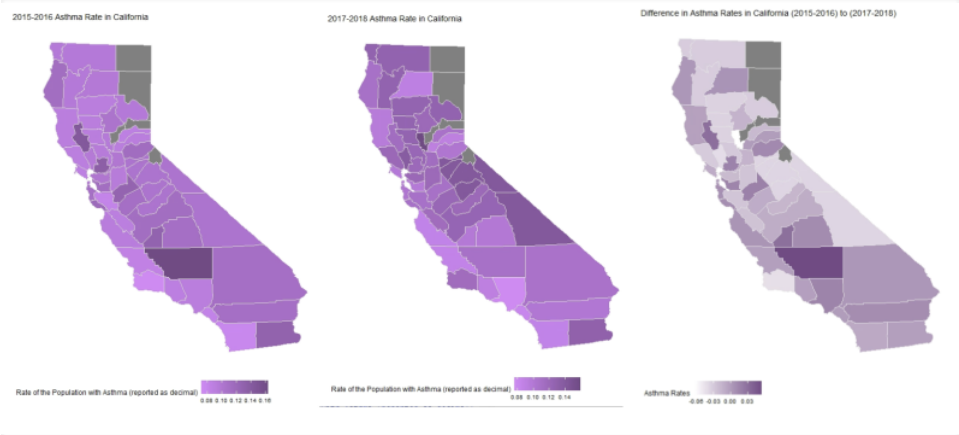

Image 4: Asthma Rates by California Counties
The rightmost map is of the difference between the Years

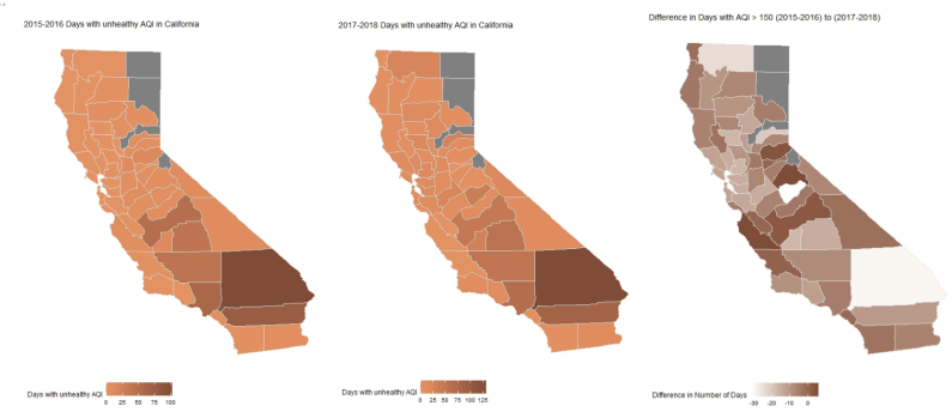

Image 5: Asthma Rates by California Counties
The rightmost map is of the difference between the Years

Discussion and Future Directions:

There were several limitations to address with this analysis. The most significant of which was related to data quantity. The asthma dataset was limited to the years 2015-2018 and so this analysis was constrained to those years. However, the AQI data was available from 1980-2021. In future elaborations to this analysis would benefit by having more time periods to examine the relationship between AQI and asthma rates. This way outliers can be ruled out and long-term trends can be observed. Another limitation of this analysis was incomplete data. Both data frames included empty cells that resulted in entire rows being removed from the dataset. There were also several counties in both data frames that did not report data which can be observed in the grey areas in Images 4 and 5. Furthermore, in the AQI data set, there were several counties that did not report their for all 365 days of the year, this could possibly have resulted in a low count of the number of days the AQI was over 150 in these counties and corrupted the analysis. In a 2017 study, O'Lenick et al. established that children living in lower SES neighborhoods in Atlanta, Georgia are at higher risk for developing asthma. Thus, in future elaborations of this analysis, I would include income levels or socioeconomic status (SES) per California county to examine the effects has on the relationship between asthma rates and the number of days with unhealthy air quality.

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