Analyzing the Relationship Between Air Quality Index (AQI) and Asthma Outcomes Across Counties

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***Abstract*—This study investigates the relationship between Air Quality Index (AQI) levels and various asthma outcomes across counties. We aim to identify areas and populations most affected by poor air quality by utilizing multiple visualizations created in Tableau, including heatmaps, triple combination charts, tree maps, point maps, and grouped bar charts. The insights gained from this analysis can guide public health researchers and policymakers in implementing targeted interventions to improve air quality and reduce asthma-related health issues.**

I. Introduction

Asthma is a chronic respiratory condition that significantly impacts public health. It affects millions of individuals worldwide, leading to hospitalizations, emergency department (ED) visits, and, in severe cases, mortality. Numerous studies have established a connection between air pollution and exacerbated asthma symptoms. Given the increasing concerns about air quality, it is crucial to comprehensively explore the relationship between Air Quality Index (AQI) levels and asthma outcomes.

This study focuses on analyzing AQI levels and their association with asthma outcomes across different counties. By visualizing these relationships, we aim to provide actionable insights for public health researchers and policymakers to target interventions more effectively. Our work highlights the importance of improving air quality to mitigate the adverse effects of asthma.

II. Related Work

Previous research has shown that air pollution significantly contributes to asthma exacerbations. Studies have demonstrated that pollutants such as particulate matter (PM2.5 and PM10), ozone (O3), nitrogen dioxide (NO2), and sulfur dioxide (SO2) can worsen asthma symptoms, leading to increased hospitalizations and mortality rates.

While many studies have examined the impact of air pollution on asthma, few have provided granular insights at the county level. Our study builds on this existing body of research by offering detailed visualizations that highlight specific areas and demographic groups most affected by asthma due to poor air quality. This approach allows for more targeted public health interventions.

III. Methods

a) Data Sources: •**AQI Data**: Collected from the Environmental Protection Agency (EPA) database, providing daily AQI values for various pollutants.

• **Asthma Data**: Sourced from county health departments, including data on asthma prevalence, hospitalization rates, ED visit rates, and mortality rates.

• **Demographic Data**: Obtained from the U.S. Census Bureau, including population distributions by age, gender, and other relevant demographic factors.

b) Data Limitations: • **Demographic Data**: We were unable to obtain data for all demographic groups, limiting our analysis's granularity.

• **AQI Data**: AQI levels were not available for every county, so some counties were excluded from the analysis.

c) Data Preprocessing: • Cleaned and normalized data to ensure consistency across different datasets.

• Aggregated data at the county level for analysis, ensuring that all data points are comparable.

• Handled missing values and outliers to maintain the integrity of the dataset.

d) Visualization Tools: • **Tableau**: Used to create all visualizations. Tableau's robust visualization capabilities allow for integrating multiple data sources and creating interactive, insightful charts and maps.

IV. Results

a) Heatmap with Label Overlay:• **Description**: This visualization displays AQI levels using color encoding and overlays asthma rates as labels on each county.

• **Insights**: The heatmap reveals that counties with high AQI levels often exhibit higher asthma rates. Urban areas with higher pollution levels show significant asthma prevalence, indicating a strong correlation between air quality and asthma.

b) Triple Combination Chart:•**Description**: This chart shows AQI levels as bars and asthma hospitalization rates, ED visit rates, and mortality rates as lines.

• **Insights**: The combination chart highlights a clear trend where higher AQI levels are associated with increased asthma-related health issues. This visualization allows for the comparison of multiple datasets, demonstrating how worsening air quality correlates with higher rates of hospitalizations, ED visits, and asthma-related deaths.

c) Tree Map: •**Description**: This treemap represents the demographic distribution of asthma cases, with area indicating the size of each demographic group and color indicating the percentage of asthma cases.

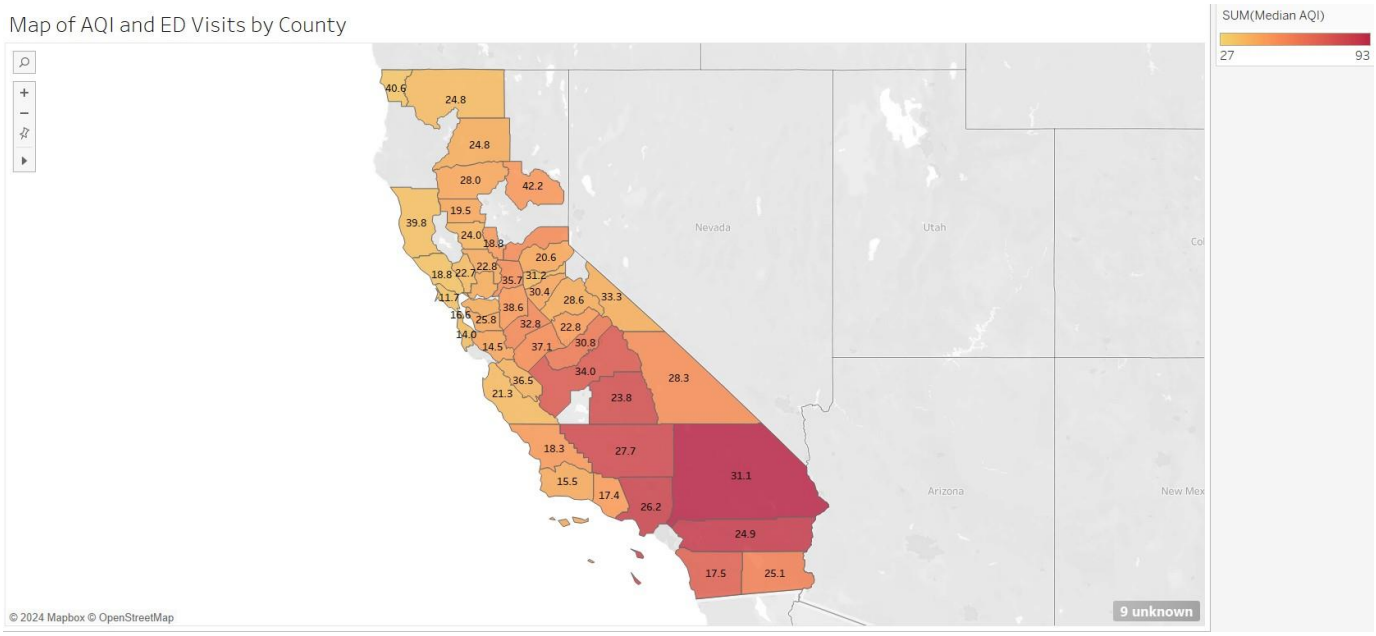

Fig. 1. Heatmap with Label Overlay Showing AQI and Asthma Rates

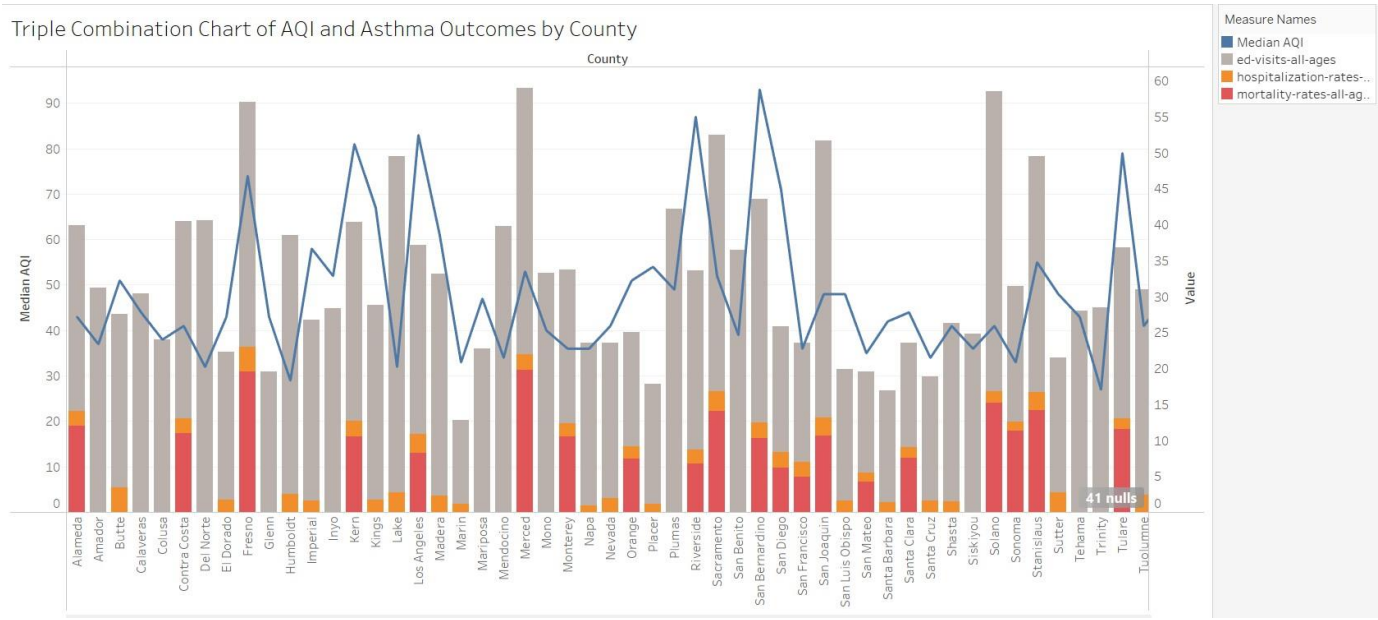

Fig. 2. Triple Combination Chart Showing AQI and Asthma OutcomesTree Map Showing Demographic Distribution of Asthma Cases

• **Insights**: The treemap shows that children and the elderly are the most affected demographic groups. This information is crucial for designing targeted interventions to protect these vulnerable populations from the adverse effects of poor air quality.

d) Point Map: •**Description**: Points on this map represent counties, with the size of each point indicating asthma mortality rates and the color indicating AQI levels.

• **Insights**: The point map identifies hotspots with high mortality rates and poor air quality. Industrial regions, in particular, exhibit high mortality rates, suggesting that pollution from industrial activities significantly impacts asthma outcomes.

e) Grouped Bar Chart: •**Description**: This chart compares AQI levels and asthma prevalence by county, with bars representing each metric.

• **Insights**: The grouped bar chart illustrates that counties with higher AQI levels generally show higher asthma prevalence. This visualization underscores the impact of air quality on asthma, reinforcing the need to improve air quality to reduce asthma-related health issues.

V. Discussion

The visualizations comprehensively show how air quality affects asthma outcomes across counties and demographics.

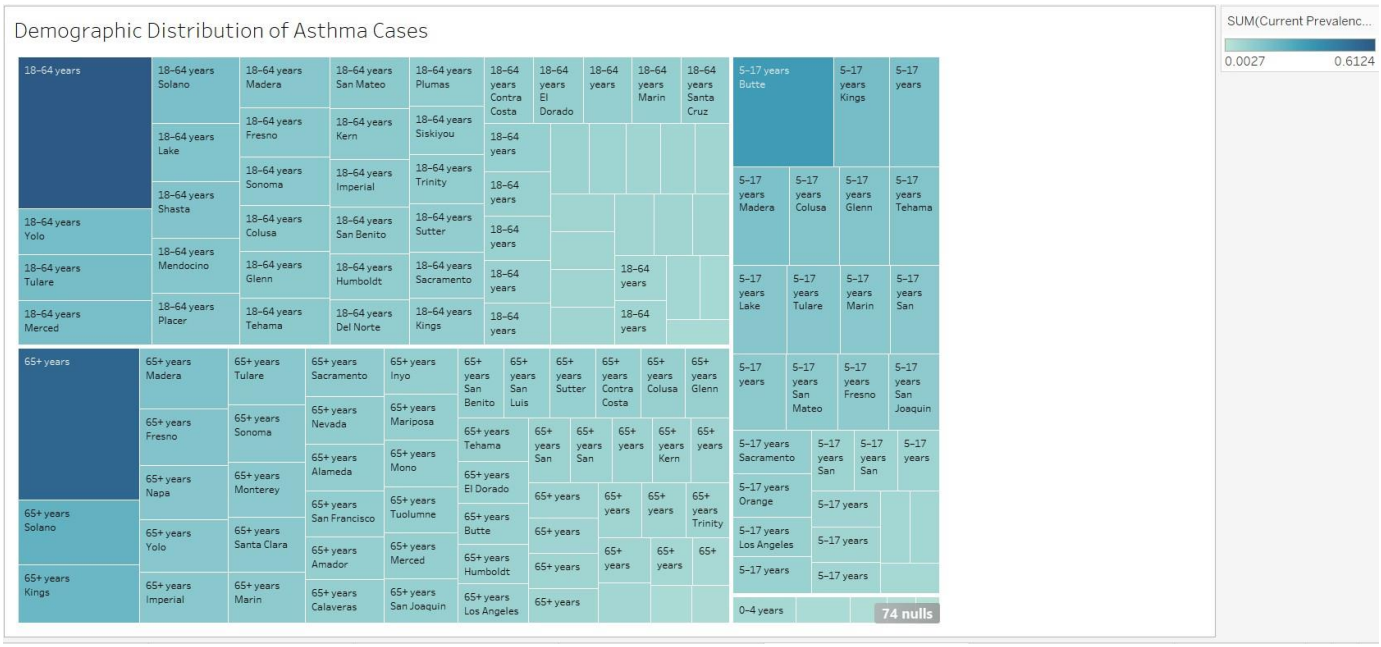

Fig. 3. Tree Map Showing Demographic Distribution of Asthma Cases

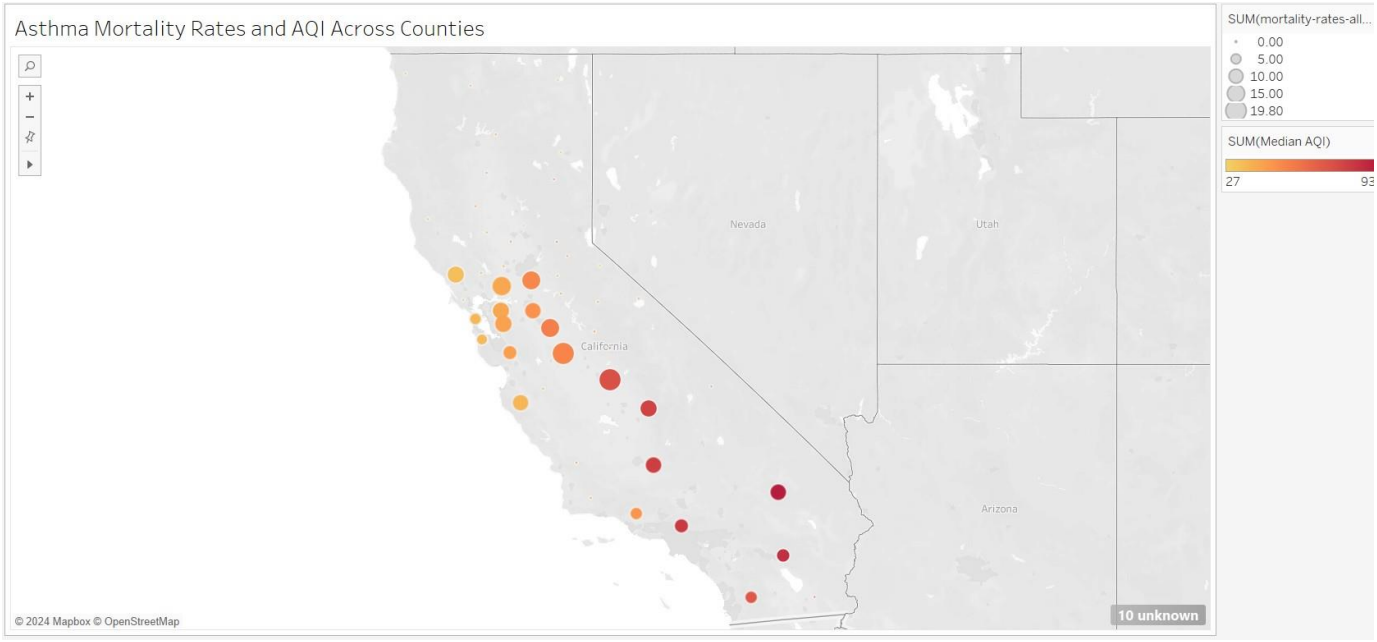

Fig. 4. Point Map Showing Asthma Mortality Rates and AQI Across Counties

The findings highlight specific areas and populations that require targeted public health interventions. For example, urban counties with high AQI levels and significant asthma rates should be prioritized for air quality improvement programs.

The combination of multiple visualizations allows for a multi-faceted analysis of the data. Heatmaps and point maps reveal spatial distributions, while combination charts and grouped bar charts facilitate the comparison of different metrics. Treemaps provide insights into the demographic distribution of asthma cases, highlighting the most vulnerable populations.

Despite this study's comprehensive nature, certain limitations exist. The unavailability of demographic data for all groups and the lack of AQI data for every county restrict the scope of our analysis. Future studies should aim to obtain more complete datasets to provide a more thorough understanding of the relationship between air quality and asthma outcomes.

VI. Conclusion

This study underscores the importance of addressing air quality to mitigate asthma-related health issues. By providing detailed visualizations and analysis, we offer valuable insights

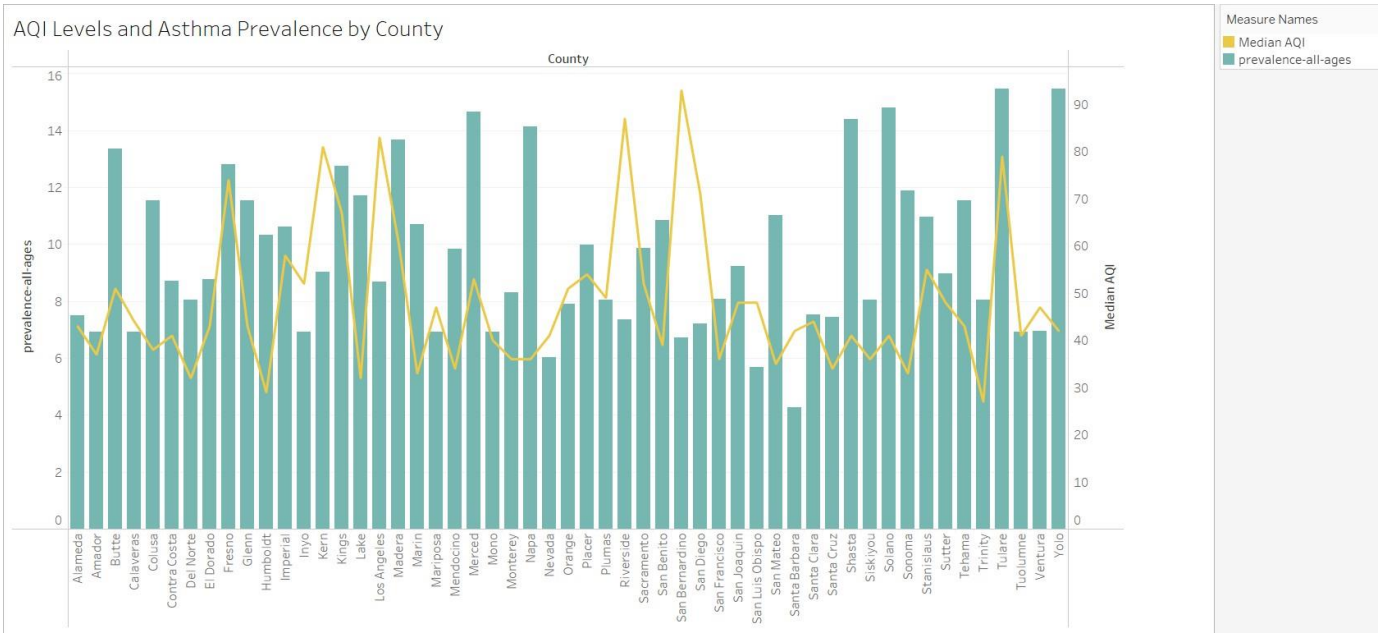

Fig. 5. Grouped Bar Chart Showing AQI Levels and Asthma Prevalence by County

for researchers and policymakers to design effective interventions. Future work could expand this analysis to include additional environmental factors and longitudinal data to better understand long-term trends.

Improving air quality is a critical public health goal that can significantly reduce the burden of asthma. Targeted interventions, informed by comprehensive data analysis, can help protect vulnerable populations and improve overall health outcomes.

VII. REFERNCES

- Includes all Tableau workbooks and any preprocessing scripts. https://github.com/aragakerubo/california-asthma-aqi-dashboard
- EPA AQI Data: https://aqs.epa.gov/aqsweb/airdata/download_files.html#Annual
- California Department of Public Health: https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHIB/CPE/Pages/CaliforniaBreathingCountyAsthmaProfiles.aspx
- CDC WONDER: https://wonder.cdc.gov/