The Impact of Extreme Heat Events and Poor Air Quality on Hospitalization Rates in Stanislaus County

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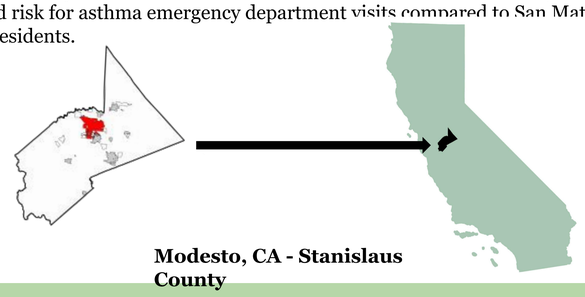
Abstract

Utilizing quantitative research methods, this study examines how air quality and heat spatially and demographically correlate with asthma hospitalizations within Stanislaus County. Through the examination of emergency department visit rates by zip code we aim to identify whether asthma hospitalization rates cluster in areas that experience higher levels of air pollution (e.g. PM 2.5, Ozone) and elevated temperatures, this can provide graphics and scientifically backed maps that allow VIP to employ spatially explicit, data-driven evidence of how environmental conditions contribute to respiratory health disparities in Stanislaus County. Modesto sits in the center of agricultural land in the Central Valley of California; the geographic context of Modesto puts the city in a vulnerable position to experience higher heat and concentrated air pollution. Our research has been conducted through the usage of Geographical Information Systems, literature reviews, and statistical analysis. Data provided by Stanislaus Health Agency and CalHHS provided us with hospitalization rates allowing the calculation of relative risk ratios. Using projected heat data, modeled analysis of days of extreme heat were produced along with spatially distributed demographic data. Preliminary results show that Stanislaus County residents are at 84% increased risk for asthma emergency department visits compared to San Mateo County residents.



Modesto, CA - Stanislaus County

Research Questions

1. **How does air quality and heat spatially and demographically correlate with asthma hospitalizations within Stanislaus County?**
2. **To what extent do air quality metrics explain variation in asthma hospitalizations after controlling for demographic variables?**
3. **How might future climate trends (increasing heat) impact asthma hospitalizations in vulnerable areas of Stanislaus County?**

Methodology

Data Collection methods:

Our primary method of gathering data was through our partnership with the Valley Improvement Project. From a previous partnership and research project, VIP was able to provide quantitative hospitalization data on heat-related admissions. This in congruence with statewide California asthma data completed our dataset.

Software and Tools:

Google Earth has been a valuable tool to get an understanding of the layout of our area, and allow better understanding of it without having been able to view it in person. Census tract data allows us to further understand important qualities of Modesto. ArcGis was also used to help us create our heat maps, and show the impacts of heat and air quality.

Using Ezri ArcGIS Pro 3.6, we subsetted our county level data set, to census tracts, that were high latino/a populations vs low latino/a population. Latino/a populations were chosen because previous research has demonstrated that in California Latino/a populations are disproportionately impacted by poor air quality, and extreme heat (Dialesandro et al 2021; Sun et al 2022).

R Studio allowed us to run statistical tests to analyze hospitalization rates. Multiple statistical tests were used to identify levels of vulnerability between groups in the study area. To compare the risk of asthma emergency department (AED) visit rates between residents of Stanislaus County and other counties in California, a relative risk (RR) and corresponding 95% confidence intervals (CI) were calculated.

Results

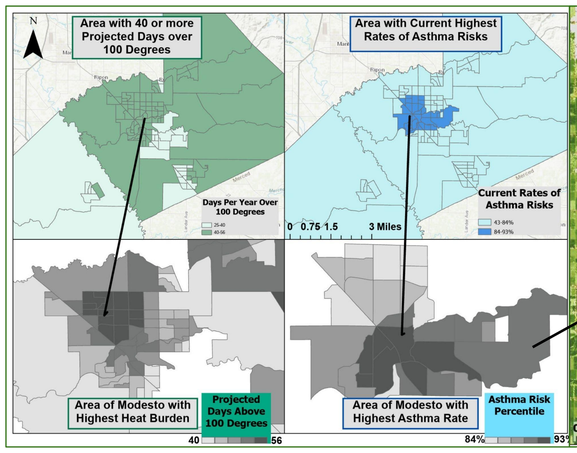


Figure 1. The Highest project Heat and Current Asthma Rates in Modesto and Stanislaus County. Data Source in the figure is based on CalEnviorScreen5 (CalEPA2026) Heat data from LOCA RCP 8.5 Mid Century.

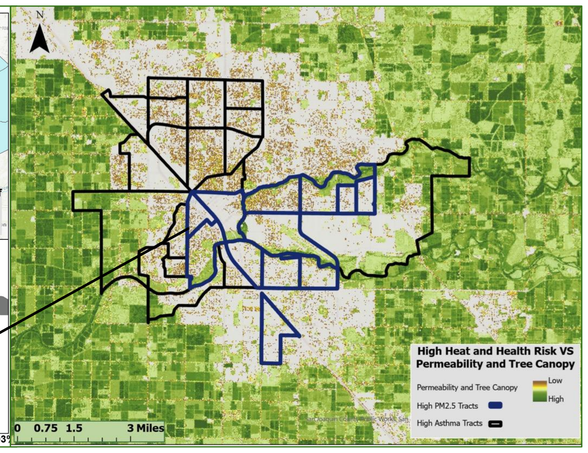


Figure 2. Area of Modesto with highest levels of PM2.5 Pollution, High levels of Asthma Risk, compared to Biophysical properties of Permeability, and Tree Canopy

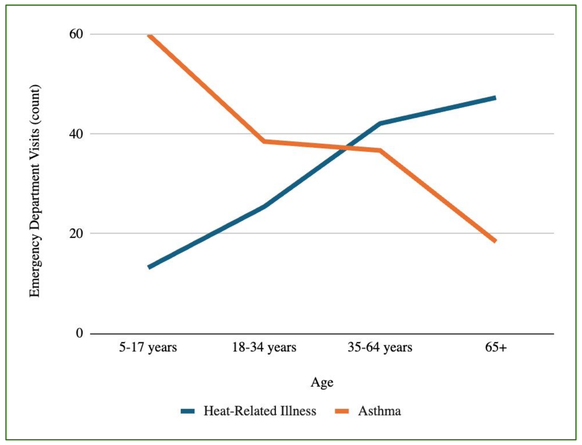


Figure 3. Stanislaus County Emergency Department Visits in 2023 by Reason for Visit and Age Group.

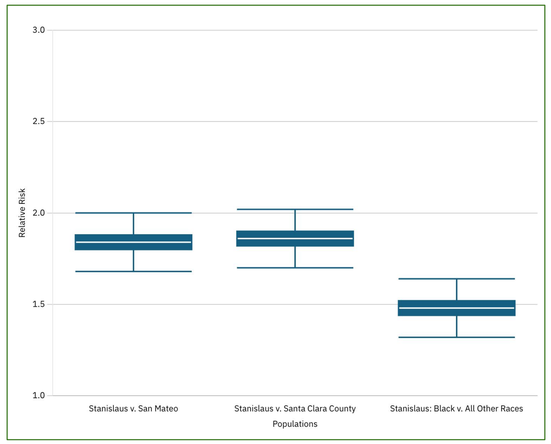


Figure 4. Relative Risk, with 95% Confidence Interval, of Asthma Emergency Department Visit Rates by Population

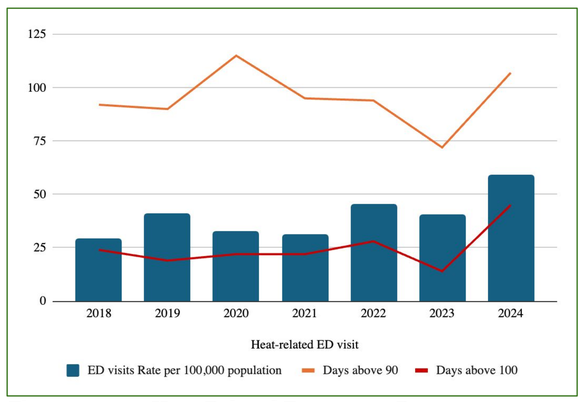


Figure 5. 2022 Heat-Related Emergency Department Visit Rates vs. Days per Year above 90°F and 100°F.

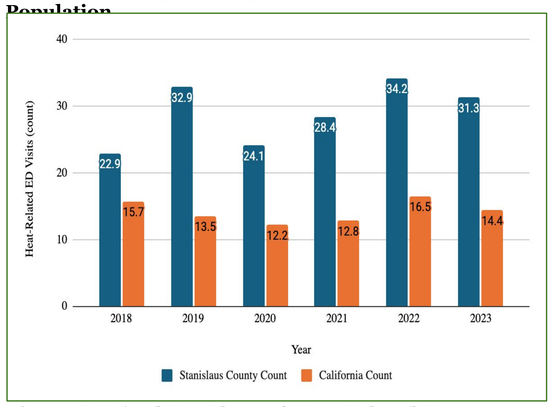


Figure 6. Paired Bar Chart of Heat-Related Emergency Department Visits in Stanislaus County v. CA by Year.

Discussion

Through our research assessing emergency department data, a spatial pattern emerged showing the disparities between heat related illness and asthma rates in Stanislaus County. We found that **areas that consistently exhibited higher overall temperature for prolonged periods of time also showed elevated rates of asthma related emergency department visits (EDV)**. Student T-tests of projected data from the mid and late century revealed that **Latinx populations experience higher concentrations of PM2.5** (sig t = -2.74, df = 34.48, p = 0.0096).

Due to the high percentage of Latinx populations in Stanislaus County (51.5%, Census Bureau 2025), further studies would be required to understand disproportionate effect relative to the demographic groups of the county. In general, **Stanislaus County faced an increased hospitalization burden due to heat-related admission in comparison to the rest of California highlighting their geographical vulnerability**. Since 2018 the gap between Stanislaus County's EDV rates versus California's EDV rates has widened from 7.2 more per 10,000 population to 16.9 more in 2023.

Through conducting relative risk (RR) analysis, we were able to conclude that there was an **84% increased risk for EDV in Stanislaus County residents compared to San Mateo County residents**. **Those who live in Stanislaus County were 1.86 times as likely to visit the emergency department for asthma than residents of Santa Clara County.**

Comparison Group (Exposed: Stanislaus County)	Increased Risk of Asthma EDV
San Mateo County	84.6%
Santa Clara County	86.3%
All Race Groups (Exposed Group: African American)	48.8%

When looking at demographic information, **African American residents were 1.48 times as likely to visit the emergency department for asthma than all other race populations who live in Stanislaus County**. Other demographic factors analyzed included age groups. **Older age groups are more likely to visit the emergency department for heat-related illness than for asthma related admission**. In contrast, **children (ages 5-17) are more at risk for asthma EDV than older populations**. Impacts of asthma and extreme heat do not have proportional effects across race or age demographic.

Conclusion

Our research has examined the relationship between extreme heat, asthma related health risk, and air quality in Stanislaus County. We identified both geographic and demographic vulnerabilities within the county and as a county as a whole. As climate change continues to intensify extreme heat events, proactive strategies will be critical to protecting vulnerable populations and reducing preventable health burdens in Stanislaus County. We aim for this study to raise awareness to existing health inequities shown by our data in order to lobby for more resources and research on mitigation strategies in the future.

Acknowledgements

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