**DATA 512: Final Project Report**

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# Introduction:

This project studied the present and future impact of wildfire smoke on the residents of Richland Washington, a city in Benton County. My work began by estimating the air quality near the city through acquiring wildfire data, AQI data, and by constructing my own smoke estimate. I then attempted to predict the future air quality of the city. Next, I turned my attention to potential health impacts of smoke on Richland residents by retrieving population and healthcare data and performing various analyses.

This area of study is important and has significant implications for the city leaders. Quantifying and predicting the impact of wildfire smoke on the health of Richland will aid city leaders in understanding what kind of threats this poses in the coming years. Additionally, it will help support their decision-making on where to allocate the city’s limited funds and whether healthcare institutions will require aid in treating related affects.

The findings of this study may also be of interest to the general population as well and help to keep them informed of risks to their health.

# Background/Related Work:

While studying the effects of wildfires on the specific city of Richland, WA may be relatively novel, research on the impact of wildfire smoke on health, more broadly, is certainly not sparse. I surveyed a variety of relevant research publications (see e.g. references [6] through [14]) to better inform my work. For instance, I came across an article that recounted a meta-analysis of many different relevant studies which helped me build my familiarity with the research topic (Source [9].).

Through my research I learned several important facts to help provide context. First, much work has been done to provide evidence that wildfire smoke is having a deleterious impact on human health. According to [6], “Previous epidemiologic studies of PM2.5 during wildland fire-smoke events have reported primarily positive and consistent associations with respiratory effects ([Delfino et al. 2009](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6768318/#c8); [Liu et al. 2017](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6768318/#c22); [Moore et al. 2006](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6768318/#c24); [Mott et al. 2005](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6768318/#c26); [Rappold et al. 2011](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6768318/#c28))”. For instance, [7] found a 7.2% greater risk of admissions for respiratory illness on poor air-quality days when the air quality was below a particular threshold, due to wildfire smoke (particularly PM2.5). These findings increased my confidence that I would likely find significant results from analyzing the connection between wildfire smoke and health conditions.

Additionally, I learned several other things that influenced my analysis. For one, I noted that in [8]., the authors divided the number of health establishment “visits by the population at risk” (pg. 106). I decided to implement this technique in my analyses, as it would help me control for the effects of changes in the population size. The articles surveyed also influenced my choice in which respiratory diagnoses I would study (Sources: TBD ).

While I had a rough idea of my project focus before surveying the current literature, reading through a variety of articles clarified my approach. Ultimately, I settled on the research question “How will wildfire smoke impact the number of hospitalizations for respiratory issues in Richland, WA in the coming years?”

My preparatory investigation also yielded several useful datasets to extend my analysis beyond the general exploration of wildfire smoke and support the further analysis needed to address the research question. First, I utilized population estimate data from the Census Bureau, a government entity [1]. This data was useful because it allowed me to control for population in my analyses. The lowest level of granularity provided was for the county-level, so I exported the data for Benton County. The data was stored across multiple files ([2]. and [3].) that required separate downloading and preprocessing. While I could not locate a license or terms of use for the data on the webpages, the data files contained a suggested citation. Additionally, I called their customer service line and got confirmation from an agent that the data is provided for public use and I was free to use it as long as I cite it. Ultimately, I ended up using a range of data from 2010 – 2022, with a couple of years thrown out.

It is not easy to find openly available healthcare data (for obvious reasons), but after some searching, I discovered the Agency for Healthcare Research and Quality (AHRQ) [4]. The AHRQ provides an interactive dashboard on their website to examine various healthcare data points, called the Healthcare Cost and Utilizations Project (HCUPnet) [5]. The site makes it clear that the user of the data is not permitted to make attempts to identify individuals or healthcare establishments in the data.

I extracted data on the number of patient discharges, for Benton County, for various diagnosed conditions. In particular, the data contained the following fields for the selected county and year:

* *Number of Discharges*
* *Average Length of Stay (in days)*
* *Rate of Discharges per 100,000 Population*
* *Age-Sex Adjusted Rate of Discharges per 100,000 Population*
* *Aggregate Hospital Costs (in $)*
* *Average Hospital Costs per Stay (in $)*

I exported the Benton County data from the tool for each year and then processed the data. For my analysis, I needed only the number of discharges for each year.

# Methodology:

* TBD: I think this would be a good place to discuss what healthcare conditions I selected and why. Reference background literature survey in the previous section

# Findings:

//where you put your visualizations

# Discussion/Implications:

# Limitations:

* I didn’t take lag effects or time series elements into account in my model. Source [10] argues for modeling lag effects, not just immediate: *Previous studies (*[*Braga et al. 2001*](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3230437/#r2)*;*[*Pope et al. 2008*](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3230437/#r23)*) have determined that air pollution produces immediate and delayed effects on morbidity and mortality and that the time to adverse outcome may vary by pollutant and health outcomes.*
* [6]. includes several variables to account for confounding effects (via day of week, temperature, humidity)
* Source [7]. includes total population *at risk*. Does HCUP give ages? If not, this is another limitation of the study.

# Conclusion:

# References:

* [6]. *DeFlorio-Barker S, Crooks J, Reyes J, Rappold AG. [Cardiopulmonary effects of fine particulate matter exposure among older adults, during wildfire and non-wildfire periods, in the United States 2008-2010](https://www.ncbi.nlm.nih.gov/pubmed/30875246). Environ Health Perspect 2019;127(3):37006. doi: 10.1289/ehp3860.*
* [7]. Liu JC, Wilson A, Mickley LJ, Dominici F, Ebisu K, Wang Y, et al.. 2017. Wildfire-specific fine particulate matter and risk of hospital admissions in urban and rural counties. Epidemiology 28(1):77–85, PMID: 27648592, 10.1097/EDE.0000000000000556. [[PMC free article](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5130603/)] [[PubMed](https://pubmed.ncbi.nlm.nih.gov/27648592)] [[CrossRef](https://doi.org/10.1097%2FEDE.0000000000000556" \t "_blank)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=Epidemiology&title=Wildfire-specific+fine+particulate+matter+and+risk+of+hospital+admissions+in+urban+and+rural+counties&author=JC+Liu&author=A+Wilson&author=LJ+Mickley&author=F+Dominici&author=K+Ebisu&volume=28&issue=1&publication_year=2017&pages=77-85&pmid=27648592&doi=10.1097/EDE.0000000000000556&)].
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* [9]. Liu JC, Pereira G, Uhl SA, Bravo MA, Bell ML. 2015. A systematic review of the physical health impacts from non-occupational exposure to wildfire smoke. Environ Res 136:120–132, PMID: 25460628, 10.1016/j.envres.2014.10.015. [[PMC free article](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4262561/)] [[PubMed](https://pubmed.ncbi.nlm.nih.gov/25460628)] [[CrossRef](https://doi.org/10.1016%2Fj.envres.2014.10.015" \t "_blank)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=Environ+Res&title=A+systematic+review+of+the+physical+health+impacts+from+non-occupational+exposure+to+wildfire+smoke&author=JC+Liu&author=G+Pereira&author=SA+Uhl&author=MA+Bravo&author=ML+Bell&volume=136&publication_year=2015&pages=120-132&pmid=25460628&doi=10.1016/j.envres.2014.10.015&)].
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# Data Sources:

* [1]. <http://www.census.gov/>
* [2]. Annual Estimates of the Resident Population for Counties in Washington: April 1, 2010 to July 1, 2019 (CO-EST2019-ANNRES-53). Source: U.S. Census Bureau, Population Division. Release Date: March 2020. Link: <https://www.census.gov/data/datasets/time-series/demo/popest/2010s-counties-total.html>.
* [3]. Annual Estimates of the Resident Population for Counties in Washington: April 1, 2020 to July 1, 2022 (CO-EST2022-POP-53). Source: U.S. Census Bureau, Population Division. Release Date: March 2023. Link: <https://www.census.gov/data/tables/time-series/demo/popest/2020s-counties-total.html>.
* [4]. <https://www.ahrq.gov/>
* [5]. <https://datatools.ahrq.gov/hcupnet/>