

# Analysis Report: Health Impact Analysis of Wildfire Smoke on Renton Residents

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## Project Focus and Objectives

The rise of wildfires in recent years has made smoke-related health issues a significant concern, especially in urban areas close to forests. This project extension aims to analyze the health impact of wildfire smoke on residents of Renton, particularly focusing on respiratory health issues such as asthma, bronchitis, and COPD exacerbations.

This study seeks to inform local policymakers about the extent to which wildfire smoke contributes to increased hospital visits for respiratory conditions. This analysis has the potential of guiding resource allocation, and strengthening public health advisories. Hospitals can take specific actions to prepare for increased respiratory-related visits: They can increase stockpiles of essential respiratory treatment supplies, such as inhalers, nebulizers, and oxygen tanks during peak wildfire seasons; develop triage protocols to prioritize patients needing urgent care and reduce congestion in emergency rooms. Healthcare providers can expand telemedicine services for patients who may benefit from remote care options.

## Background / Focus

The Primary focus of this extension plan is Health care - specifically, the increase in hospital visits and emergency room admissions for respiratory illness related to smoke exposure. By quantifying the impact of smoke on respiratory health, this study will provide insights into the demand for healthcare services during wildfire events and help in creating targeted health interventions for vulnerable groups in Renton, Washington.

Previous research highlights that exposure to wildfire smoke is linked to a rise in respiratory-related hospitalizations. Studies such as **“Wildfire Smoke and Cardiopulmonary Hospital Admissions in the Western United States” (Liu et al., 2017)** have shown that particulate matter from wildfires exacerbates conditions like asthma and chronic obstructive pulmonary disease (COPD).

While numerous studies focus on high-level trends, fewer have examined localized impacts, particularly for Renton. To fill this gap, I used models like ARIMA for temporal forecasting and analyzed a range of datasets, including hospital admissions, smoke impact estimates, and air quality indices (AQI).

## Research Questions

1. How do wildfires affect air quality?
2. What's the relationship between air quality, wildfire smoke, and respiratory hospital visits?
3. Can we predict future respiratory visits based on historical trends?

## Data Acquisition Plan

To assess the health impacts accurately, I plan to integrate wildfire data from Part 1 with health-related datasets that reflect respiratory health trends in Renton and King County.

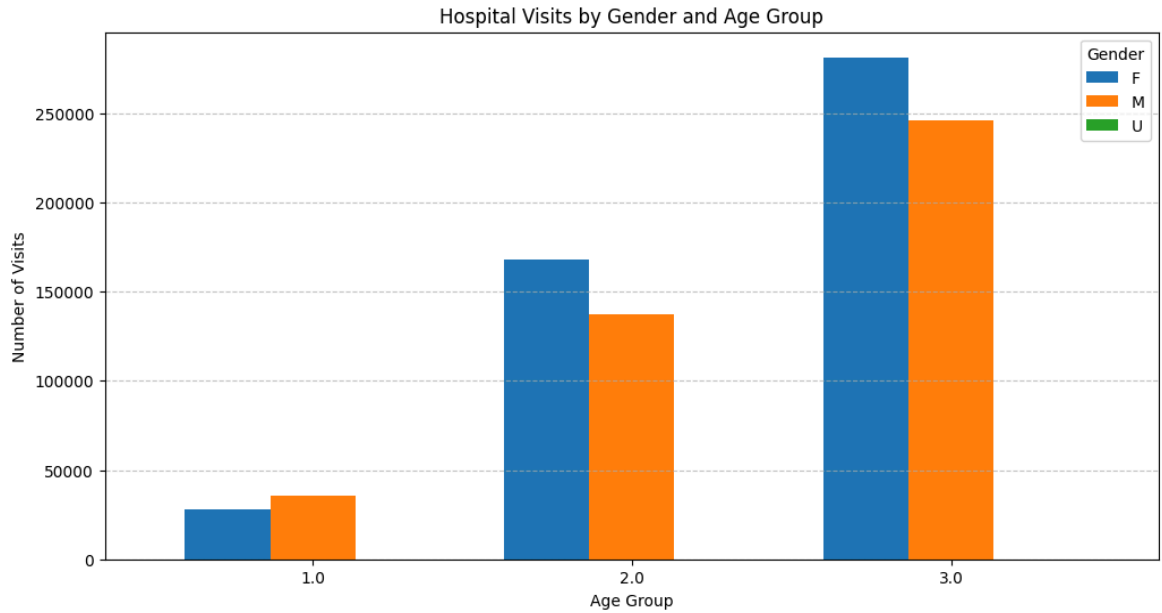
## Data Sources

- **Hospital Data:** Respiratory-related hospital admissions grouped by year, ICD-10 codes, and ZIP codes.
- **Wildfire Data:** Historical fire size and proximity from the **USGS Wildland Fire Dataset**, filtered for fires within 650 miles from Renton.
- **Air Quality Data:** Annual AQI values and estimates of smoke impact on air quality.

## Analytical Approach and Model Justification

The health impact analysis will involve correlating smoke exposure levels with respiratory health metrics over time. The goal is to quantify potential increases in respiratory health incidents due to wildfire smoke. I will use the following analytical steps and models:

1. **Exploratory Data Analysis (EDA):**
  - Visualized hospital visit trends, gender, and age group distributions.
  - Correlation analyses to explore the relationships between smoke, AQI, and hospitalizations.



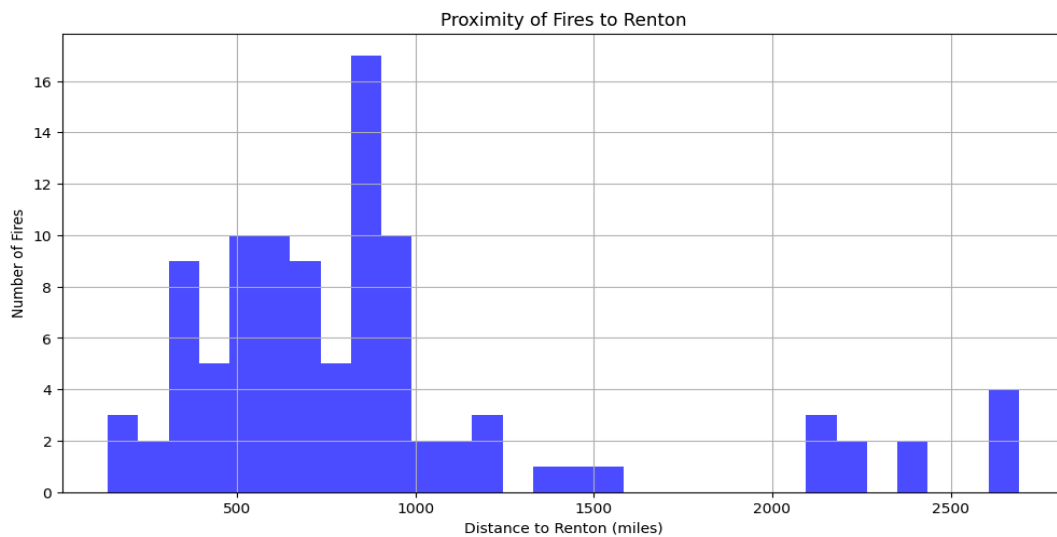
**Figure 1:** Bar graph of hospital visits by gender and age group.

## 2. Correlations:

- Smoke impact and AQI:  $r = 0.037$  ( $p = 0.87$ ), indicating a weak relationship.
- Mean GIS Acres (fire size) and Respiratory Visits:  $r = 0.21$  ( $p = 0.35$ )
- Mean AQI and Respiratory Visits:  $r = -0.18$  ( $p = 0.44$ )

## 3. Wildfire Proximity and Trends:

- Analyzed the spatial and temporal patterns of fires near Renton.
- Examined distances between fire perimeters and the city.



**Figure 2:** Histogram of fires by distance from Renton.

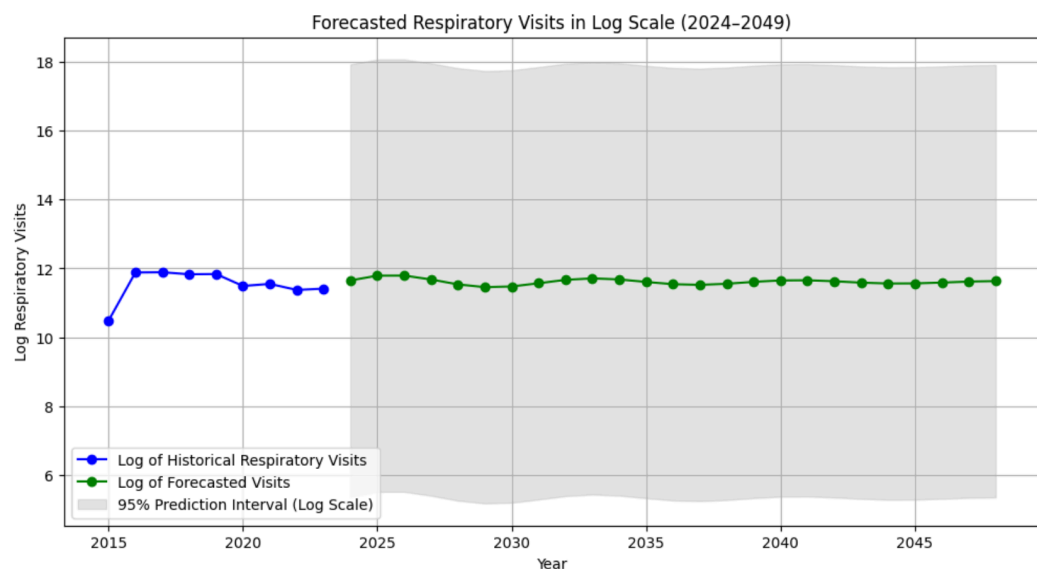
#### 4. Time Forecasting with ARIMA

To predict future hospital visits, I applied the ARIMA model:

- **Cross-Validation for Parameter Selection:**
  - A grid search was conducted over parameter ranges (p,d,qp,d,q) using rolling cross-validation. This ensured robust estimation of parameters by testing performance across multiple data splits.
  - The root mean square error (RMSE) was calculated for each parameter combination, and the model with the lowest average RMSE was selected.
- **Training and Testing:**
  - The dataset was divided into training and testing subsets.
  - The best ARIMA configuration, determined through cross-validation, was trained on the historical data.
- **Forecasting:**
  - Using the best-fit ARIMA model, I forecasted hospital visits for the next 25 years (2024–2049).
  - Confidence intervals were computed to quantify the uncertainty in predictions.
- **Validation:**
  - Residual analysis was performed to confirm model assumptions, such as stationarity and normality of residuals.

#### 5. Integration and Scaling:

- Combined smoke, AQI, and hospital data into a unified dataset, scaling values for joint visualization and interpretation.



**Figure 3:** Forecasted Respiratory Visits (2024 - 2049)

#### Ethical Considerations:

- **Data Privacy:** Aggregated hospital data to prevent individual identification.
- **Transparency:** Detailed documentation of all analytical methods.
- **Inclusivity:** Focused recommendations to protect vulnerable populations, such as seniors and individuals with pre-existing conditions.

## **Discussion / Implications**

Several external factors may impact the ability to fully address the research questions, particularly in the context of Renton's specific location and air quality dynamics. These dependencies could introduce variability or limit the conclusiveness of the findings:

- Renton's air quality can be impacted by various sources unrelated to wildfire smoke, such as vehicle emissions, industrial pollutants (e.g. Boeing Plant), and seasonal weather patterns. During certain times of the year, other pollutants might contribute to poor air quality, complicating the isolation of wildfire smoke as the primary factor influencing respiratory health. This dependency may necessitate controlling for these non-wildfire factors in the analysis, potentially requiring additional data sources.
- The weak correlations between smoke impact, AQI, and respiratory visits suggest that other factors may be influencing respiratory health outcomes in Renton. The declining trend in hospital visits since 2018, despite worsening air quality, may reflect:
  - Improved healthcare access and public health campaigns.
  - Better air filtration systems in homes and public spaces.
  - Increased use of telemedicine during poor air quality days.

## **Recommendations:**

- Enhance air filtration in senior living facilities and community centers.
- Implement a check-in system for vulnerable populations during smoke events.
- Expand telemedicine services to reduce unnecessary travel during poor air quality days.
- Develop targeted public health communications for at-risk groups, especially seniors.

## **Limitations:**

- County-level health data may not fully represent Renton-specific trends.
- The ARIMA model doesn't account for external factors like climate change or population growth.
- Limited historical data (9 years) affects the reliability of long-term predictions.

## **Findings**

**Trends in Wildfire and Air Quality:**

- The number of wildfires has been steadily increasing since the 1980s, with many occurring within 500–1,000 miles of Renton.
- A strong temporal correlation was observed between wildfire smoke impact and AQI degradation.

#### **Trends in Hospital Visits:**

- Despite worsening air quality, respiratory hospital visits in Renton have declined since 2018. This may reflect improved healthcare access, public health campaigns, or pandemic-related changes in healthcare utilization.

#### **Forecasted Hospital Visits:**

- The ARIMA model predicts that annual respiratory-related hospital visits will remain steady, ranging between 94,000 and 132,000 visits annually through 2049.
- The model also highlights uncertainty, with potential variations influenced by factors beyond wildfires, such as industrial emissions.

## **Conclusion**

While wildfire smoke impacts Renton's air quality, its direct effect on respiratory health is complex and potentially mitigated by improved healthcare and public awareness. This study underscores the need for continued monitoring, targeted interventions for vulnerable populations, and adaptive public health strategies in the face of changing environmental conditions.

## **References**

- Liu, J. C., et al. (2017). Wildfire-specific Fine Particulate Matter and Risk of Hospital Admissions in Urban and Rural Counties. *Epidemiology*, 28(1), 77-85.
- EPA Air Quality System (AQS): <https://www.epa.gov/aqs>
- USGS Wildfire Data: <https://www.usgs.gov>