

ENVIRONMENTAL ANALYSIS OF DAILY EMERGENCY DEPARTMENT VISITS IN SHELBY COUNTY

Hantao Wang, Division of Policy, Planning, and Assessment, Tennessee Department of Health

Background

According to the 2015 Global Burden of Disease Study, air pollution is a key contributor to premature mortality(1). Previous epidemiological studies have shown a correlation between severe air pollution and hospital admissions for respiratory and cardiovascular diseases(2)(3). The effects of air pollution on hospitalization have become a growing concern of public health.

Objectives

By using daily counts of emergency department (ED) visits and Air Quality Index (AQI) in Shelby County from 2000-2015, the primary objectives of this study are

- To investigate associations between air pollution and daily ED visits in Shelby County
- To evaluate the severity and timing effects of each air pollutant on common diseases
- To generalize the trend and make prediction of daily ED visits
- To provide evidence for future studies

Figure 1: flow chart of study design procedure

Air Quality Index (AQI)

Environmental Protection Agency (EPA): SO₂, NO₂, CO, Ozone, and particle matters

| AQI Levels |
|------------------------------|
| Good: 0-50 |
| Moderate: 51-100 |
| Sensitive Unhealthy: 101-150 |
| Unhealthy: 151-200 |
| Very Unhealthy: 201-300 |
| Hazardous: 300-500 |

Tennessee Hospital Discharge Data System (HDDS)

| Type | Criterion |
|--------------|--|
| ICD-9 | 350-459: Circulatory |
| | 460-519: Respiratory |
| | 520-579: Digestive |
| | 580-629: Genitourinary |
| | 800-999: Injury |
| Age | 3-11: Children |
| | >65: Elder |
| Work-related | Workers' Compensation as primary payer |

Effect Analysis

1. Analysis of air pollutants pm different diseases, age group, and types by odds ratios
2. Evaluate effect of each pollutants over time by OR and Interquartile Range (IQR)

NOAA Online Weather Data
National Weather Service

Model and Predict on future ED visits

Figure 2: Time series plot of daily ED visits with estimated trend and seasonality.

Note: Trend and seasonality were estimated by time series decomposition.

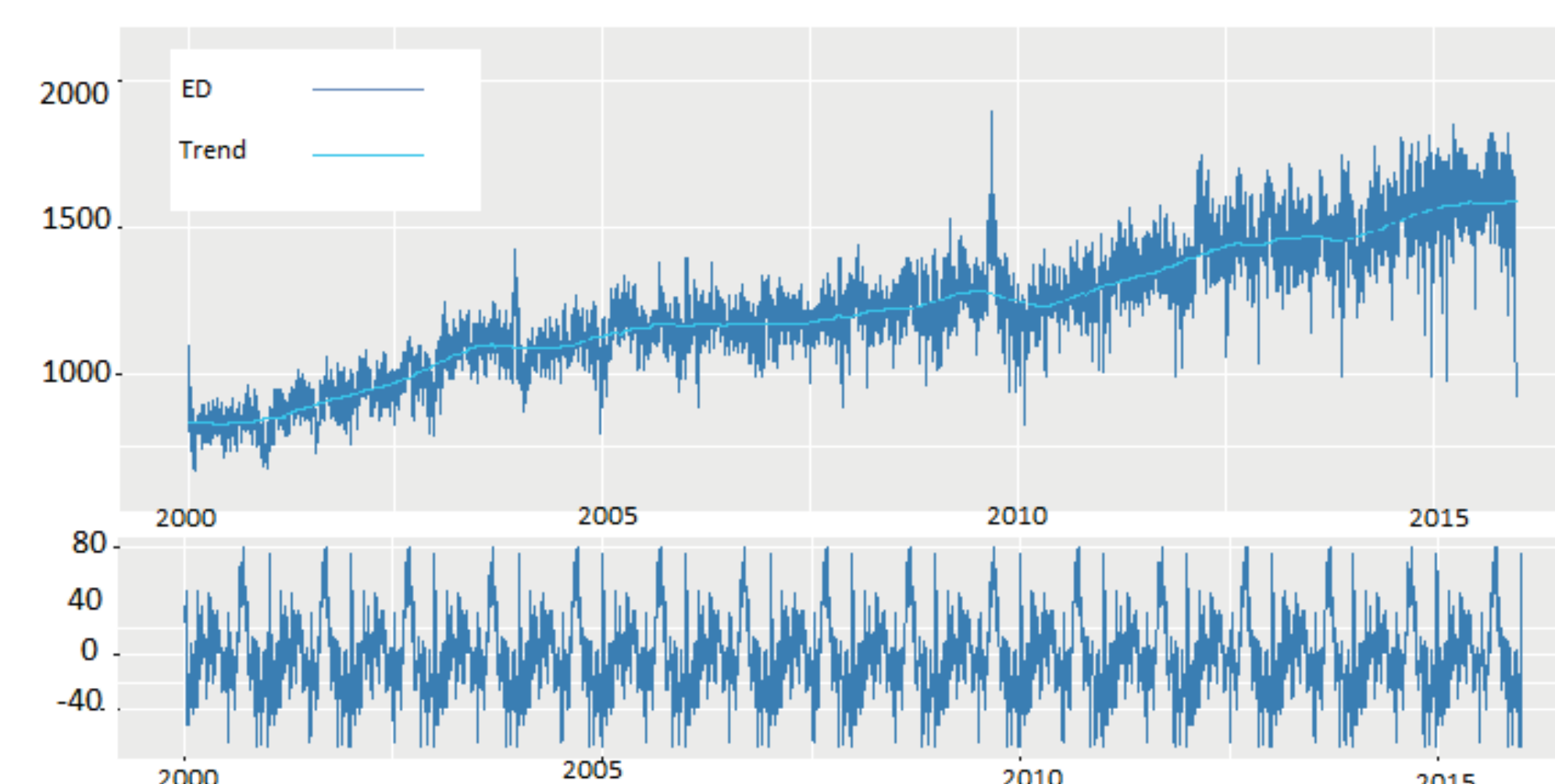
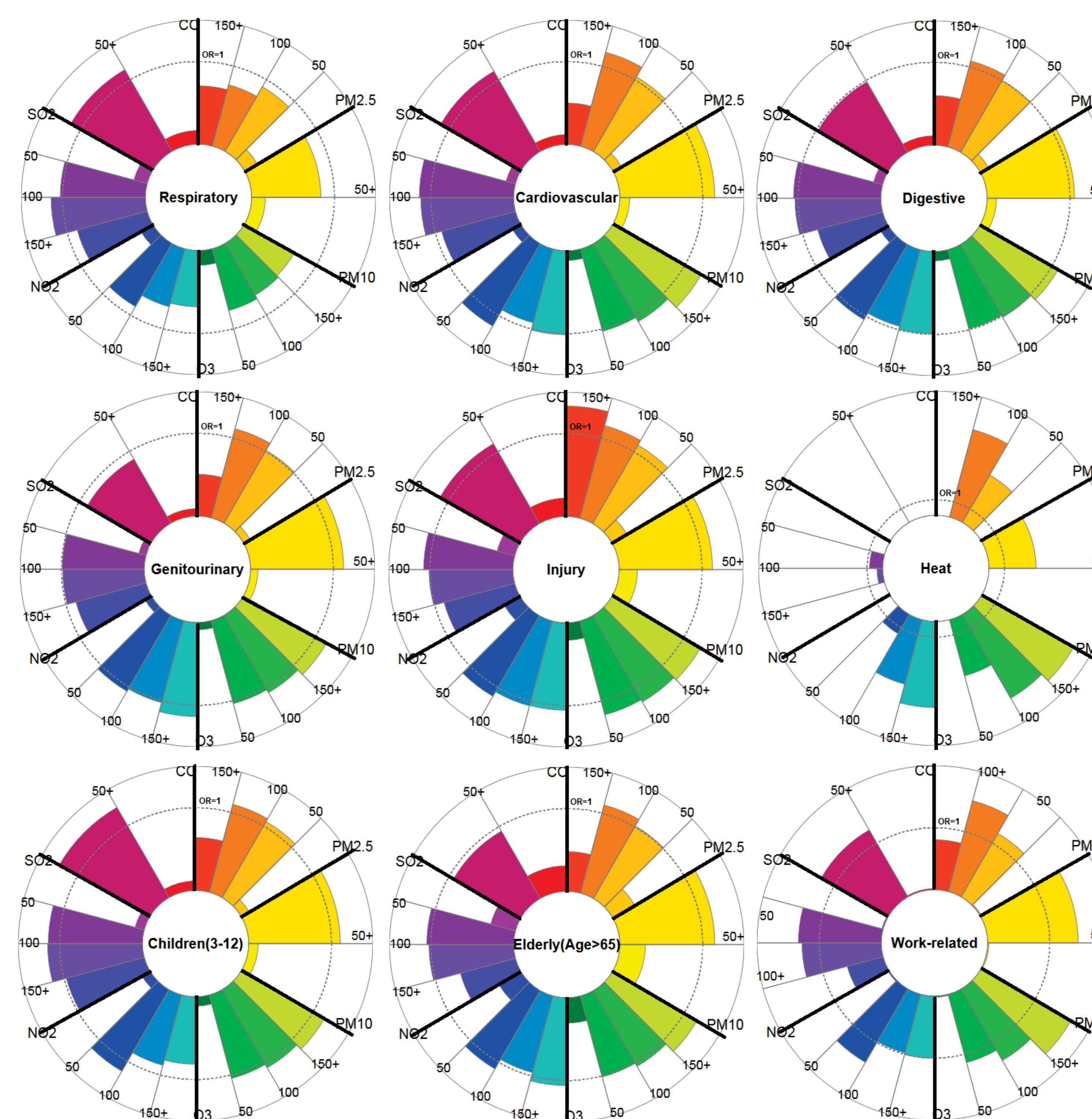


Figure 3: Odds ratio plots of 9 ED visits types by each air pollutant at different AQI levels.

Note: Dashed ring: OR=1. Odds ratios were estimated by logistic regression.



- The counts of daily ED visits in Shelby County increased every year and showed a quarterly seasonality as shown in Figure 2.
- In general, higher AQI levels were likely to result more ED visits when compared to good air quality condition (AQI: 0-50), regardless of pollutants, age group, diagnosis and type of ED. Details of odds ra-

tios of a selection of 9 types of ED visits by each pollutant can be found in Figure 3.

- Most pollutants showed lagging effects on ED visits. For example, moderate CO AQI(51-100) level on a given day was 1.12(95% CI: 1.05-1.19) times likely to cause more cardiovascular ED visits, which was increased to 1.24(95% CI: 1.16-1.32) at one-day lag and 1.39 (95% CI: 1.15-1.66) by 3-day moving average (MA).
- Interpreted by IQR from a multivariate regression model, 1 percentile increase in 3-day MA of each air pollutants increased ED visit

Figure 4: IQR table of lagging effect by each air pollutant

Note: Results were generated by a multivariate regression

| lag | CO | SO ₂ | NO ₂ | Ozone | PM _{2.5} | PM ₁₀ |
|--------|-------|-----------------|-----------------|-------|-------------------|------------------|
| Lag(0) | 0.488 | 0.128 | 0.222 | 0.118 | 0.166 | 0.563 |
| Lag(1) | 0.678 | 0.143 | 0.274 | 0.146 | 0.206 | 0.762 |
| MA(3) | 1.277 | 0.304 | 0.543 | 0.289 | 0.407 | 1.380 |
| MA(7) | 0.727 | 0.210 | 0.302 | 0.168 | 0.277 | 0.587 |

more than other time periods, which suggested air pollutants had a strong 3-day lagging effect. IQR table can be found in figure 4.

- Modeling 2000-2014 daily ED visits on AQI and other environmental variables (i.e. temperature, wind speed, UVI) with various machine learning methods, a final model was able to validate 2015 daily ED visits of Shelby County within 4.26% MAPE, (66/1568). Feature importance from such model also suggested high correlations of air pollutants (SO₂ and CO namely) to daily ED visits in Shelby County.

Conclusion

This study provided evidences of associations between air pollutants and daily ED visits. The model trained in this study can help hospitals to predict volume of daily ED visits and correspond accordingly. The methods and procedures used in this study can be extended to other counties in Tennessee. Similar results has already been found in Davidson County, TN.

References

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2. Fusco, D., Forastiere, F., Michelozzi, P., Spadea, T., Ostro, B., Arca, M., & Perucci, C. A. (2001). Air pollution and hospital admissions for respiratory conditions in Rome, Italy. *European respiratory journal*, *17*(6), 1143-1150.
3. Wong, T. W., Tam, W. S., Yu, T. S., & Wong, A. H. S. (2002). Associations between daily

Methods

Results