# Effects of local air quality reported using the Air Quality Index and spatial clustering effects on lung cancer mortality rates of North Carolina counties of 2000

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## Abstract

It is well known that a certain air pollution species can affect lung function and thus may impact the health of the respiratory system, which might in turn increase the risk of a certain diseases such as lung cancer. U. S. EPA has been reporting the Air Quality Index (AQI) as the indicator of local air quality to better reflect the health effects of air pollution. However, an investigation on the problem of linking AQI to the mortality rate caused by lung cancer has not been performed. In this study, we propose a Hierarchical Bayesian model that links measurements of county air quality derived from AQI, as well as the effect of spatial clustering, to the county mortality rates caused by lung cancer. We studied the lung cancer mortality rates of different races (white, black) and genders (male, female) in 45 North Carolina counties of year 2000. It is found that the county air quality derived from AQI does not have significant effects on the lung cancer mortality rates of these race-gender combinations, but spatial clustering plays an important role.

Introduction

## Introduction: What is AQI?

- An index for reporting daily air quality
- Attempting to address how the cleanness of the air, as well as the associated health effects might be a concern for the public
- Focusing on health effects you may experience within a few hours or days after breathing polluted air

## EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act:

- Ground-level ozone
- Particulate matter
- Carbon monoxide
- Sulfur dioxide
- Nitrogen dioxide

## AQI values

| AQI values | Air quality conditions of health concern |
|---|---|
| 0 to 50 | Good |
| 51 to 100 | Moderate |
| 101 to 150 | Unhealthy for sensitive groups |
| 151 to 200 | Unhealthy |
| 201 to 300 | Very unhealthy |
| 301 to 500 | Hazardous |

## AQI Data

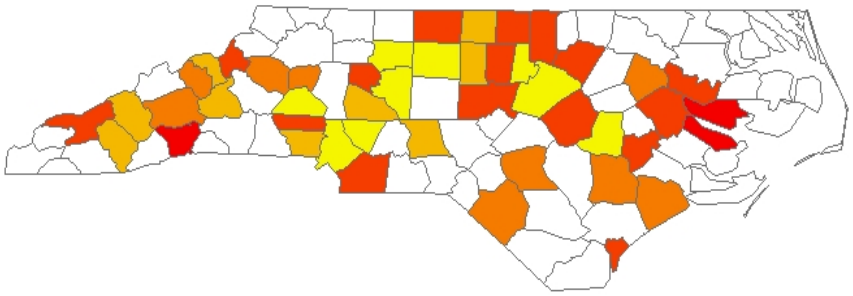
- EPA-archived daily AQI data of North Carolina counties (available for 46 out of 100 North Carolina counties)

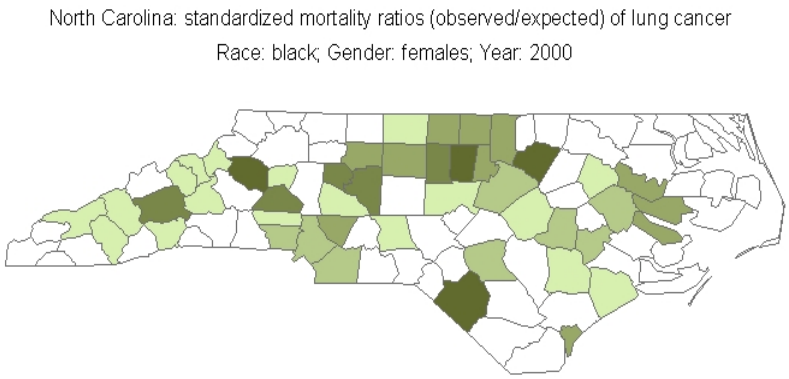
## Lung Cancer Mortality Data

- The lung cancer mortality data of North Carolina counties were obtained from North Carolina State Center of Health Statistics

## Map Examples

North Carolina: air quality measurements derived from AQI






## Model Proposed

log(*O*/*E*) = (*beta0*) + (air quality)*(*beta1*) + (*s*) + (*r*)

where

- *O* = Observed mortality rate of each county of white-male, white-female, black-male, and bleck-female
- *E* = Expected mortality rate (derived from U.S. death rates)
- *s* = spatial effect
- *r* = non-spatial residual
- Define *alpha* = sd(*s*)/[ sd(*s*) + sd(*r*) ] = proportion of contribution by spatial effects; *alpha* = 0.5 means spatial and non-spatial effects are equally important; *alpha* > 0.5 means spatial clustering effects are more important than non-spatial effects
- The conditionally autoregressive (CAR) model and the Markov chain Monte Carlo (MCMC) method were used to estimate the values of *beta0*, *beta1*, and *alpha*.

## Results

| Race | Gender | *alpha* | *beta0* | *beta1* |
|---|---|---|---|---|
| white | male | 0.69 | -0.05 | 0.14 |
| white | female | 0.66 | -0.13 | 0.15 |
| black | male | 0.79 | 0.27 | -0.19 |
| black | female | 0.75 | 0.19 | -0.32 |

## Discussion

- *beta1* closes to 0 : no significant effects by air quality for all the race-gender combinations.
- *alpha* > 0.5 : spatial clustering are more important in the variation of outcome than non-spatial effects.
- *alpha* of black population is higher than that of white population : the spatial clustering effect is more profound in black population than in white population.

## Future Studies

- Comparing the results of lung cancer to those of other types of cancers and/or other respiratory diseases
- Investigate other factors that may affect the occurrence of lung cancer on the areal level, such as SES, smoking behavior of different communities, races, and genders, areal age distribution and other demographic characteristics.