Geographical differences in prevalences and mortality rates of COPD

Ta-Chien Chan (Ph.D.)
Where is Taiwan?

San Diego is Taiwan’s neighbor on the map. In reality, it takes 18 hours to arrive...
Outline

- Brief introduction of COPD
- What are our research questions?
- Materials and Methods
- Results
- Discussion and Suggestion
Brief introduction of COPD

- Chronic obstructive pulmonary disease (COPD) is a progressive disease that makes it hard to breathe.
- COPD can cause coughing that produces large amounts of mucus (a slimy substance), wheezing, shortness of breath, chest tightness, and other symptoms.

Source: http://www.nhlbi.nih.gov/health/health-topics/topics/copd/
Disease Burden of COPD

World:
- According to WHO estimates, 65 million people have moderate to severe chronic obstructive pulmonary disease (COPD).
- More than 3 million people died of COPD in 2005, which corresponds to 5% of all deaths globally.
- In 2002 COPD was the fifth leading cause of death.
- Estimates show that COPD becomes in 2030 the third leading cause of death worldwide.

Taiwan:
- Prevalence in 2011: 16.2/100,000 persons
- 7th leading cause of deaths
Possible Risk Factors

- Smoking
- Occupational exposure
- Air pollution
- Elderly
- Gender
- SES
- TB
- Altitude
Delayed TB treatment is a risk factor for COPD

What are our research questions?

- Are there any COPD clusters in Taiwan?
- What are the possible risk factors for causing the clusters?
- What is the spatial distribution of the prevalence?
Disease Definition

- ICD 9:
  - Bronchitis (490, 491)
  - Emphysema (492)
  - Chronic airway obstruction, not elsewhere classified (496)

**Male Crude Mortality**

**Female Crude Mortality**

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Male > Female
ICD 9- 496 is the highest
Materials

- Materials
  - Age-adjusted Mortality Rates
    - Sources: Causes of Deaths Database
    - Time period: 1999-2007
    - By Township
    - By Gender
    - Reference population: 2000 Taiwan Population
  - Smoking Rates
    - Sources: 2001 NHIS
    - Time Period: 2001
    - By City/County
    - By Gender
Materials – cont.

1. Materials
   1. Air pollution
      1. Source: EPA Database
      1. PM10, SO2, NO2, CO
      1. Estimation by township
   2. Prevalence rate
      1. Source: National Health Insurance Database
      1. By township
      1. By gender
   3. Area Deprivation Index (ADI)
      1. Source: 2000 Population and Housing Census
      1. Time: 2000
      1. By township
      1. ADI = Standardized (Proportion of Elementary Occupations) + Standardized (students aged 15~17 drop-out rate from schooling)
Materials – cont.

- TB Mortality Rate (Proxy of TB exposure)
  - Sources: Causes of Deaths Database
  - Time period: 1999-2007
  - By Township
  - By Gender
  - Reference population: 2000 Taiwan Population

- Aborigines percentage
  - Source: 2000 Population and Housing Census
  - Time: 2000
  - By township
  - Number of aborigines/ township population

- Density of health care facilities

- Altitude
  - ASTER GDEM website
Methods

- **SaTScan**
  - Spatio-temporal Scan Statistics
  - Identify the COPD Mortality Clusters

- **ArcGIS**
  - Geographically Weighted Regression (GWR) and linear regression for statistical modeling
  - Empirical Bayes Kriging for interpolation of the air pollutants
  - Zonal Statistics to estimate the average air pollution concentration and altitude in each township

- **SAS**
  - Calculate the age-adjusted mortality rates, prevalence, area deprivation index, aborigines
Results


http://www.plosone.org/article/info:doi/10.1371/journal.pone.0098170
COPD age-adjusted mortality (1999-2007)

(A) Male

(B) Female


http://www.plosone.org/article/info:doi/10.1371/journal.pone.0098170
COPD Mortality Risk (M)\text{w}

Most likely S-T Clusters:

1. Spatial \text{w} 79 Townships
2. Temporal \text{w} 2004-2007

Local Risk

- 0.00 - 1.54
- 1.55 - 1.88
- 1.89 - 2.37
- 2.38 - 3.51
- 3.52 - 5.51

Kilometers
COPD Mortality Risk (F) with

Most likely S-T Clusters:

1. Spatial with 77 Townships
2. Temporal with 2002-2005
The residual map after GWR

http://www.plosone.org/article/info:doi/10.1371/journal.pone.0098170
Local Moran’s I of residual map

Global Moran’s I was not significant and close to zero.

http://www.plosone.org/article/info:doi/10.1371/journal.pone.0098170
R-square improvement

OLS†  GWR

Males  49.4%†  72.2%

Females  60.9%†  77.9%
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<tr>
<th>Variables</th>
<th>N</th>
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<th>Median</th>
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http://www.plosone.org/article/info:doi/10.1371/journal.pone.0098170
## Coefficients (GWR) – Females

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http://www.plosone.org/article/info:doi/10.1371/journal.pone.0098170
Consistent variables

- Smoking
- Aborigines
- PM10
- Altitude
2007 Male COPD prevalence rate

Per 100,000

4001+
2001 - 4000
1001 - 2000
501 - 1000
500-

2007 Female COPD prevalence rate

Per 100,000

4001+
2001 - 4000
1001 - 2000
501 - 1000
500-
Discussion and Suggestion

- Major research Questions:
  - Are there any COPD clusters in Taiwan?
  - What are the possible risk factors for causing the clusters?
Use GIS techniques to demonstrate correlations between spatial and temporal effect with some health and social parameters.

Identify the mortality clusters with Space-Time Poisson Scan Statistics.

Spatial regression can explain the spatial distribution of the disease and improve the model’s power.

Smoking, air pollution and aborigines are the major explanatory factors of COPD in ecological study.

Altitude’s effect can not be concluded here because most townships (316/358, 88.3%) are located at altitudes less than 500 m.

Prevalence will be biased by the health care facilities.

There are still some limitations of this study:
- Unknown risk factors of COPD, such as burning biofuels in the house.
- Smoking rate by township is still under estimated.

The epidemiological investigation is currently ongoing on those high risk areas.
Thank you for your attention

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Geographic Disparity in Chronic Obstructive Pulmonary Disease (COPD) Mortality Rates among the Taiwan Population

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Details in the published papers (May 2014)