Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates

Takafumi Kubota¹, Makoto Tomita², Fumio Ishioka³ and Toshiharu Fujita¹

¹The Institute of Statistical Mathematics
²Tokyo Medical and Dental University
³Okayama University

December 16-19, 2011
1 Introduction
   - Background
   - Previous Studies

2 Spatio-temporal Data of Suicide in Japan
   - Statistics of Community for the Death from Suicide

3 Spatial/Spatio-temporal Clustering
   - Spatial Clustering
   - Results of Coolspot
   - Spatio-temporal Clustering

4 Summary and Future Studies
   - Summary
   - Future Studies
Background

- When?
- Who?
  - age group
  - sex
- Where?
  - High
  - Low

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
**Background**

**Time Series of the Number of Suicide**

**White paper of suicide prevention (2011)**

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.

**Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates**
Introduction

Spatio-temporal Data of Suicide in Japan

Spatial/Spatio-temporal Clustering

Summary and Future Studies

Background

- The number of suicide rapidly increased from 1997 to 1998
  - Burst of the economic bubble (1990-1992)
  - Economic recession (1993-1997)
    → Bankruptcy, corporate downsizing, unemployment,...

- Our data: 4 time periods (5 years)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.

Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Background

Sex and Age Group of the Number of Suicide

[Bar chart showing the distribution of suicide by sex and age group.]

White paper of suicide prevention (2011)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.

Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Where are high suicide rate areas?

- Hotspots identified in Japan (Tomita, et al. (2010))
  - Tohoku district
  - Kyushu district

- Hotspots identified in Kanto district (Ishioka, et al. (2010))
  - Northwest area on Kanto district
    - Tochigi Prefecture
    - Gumna Prefecture
    - Saitama Prefecture

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.

Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Objective

- Where are **Low** suicide rate areas?

1. to measure the degree of dependency among non-suicide rate
   \(\rightarrow\) the spatial autocorrelation statistics especially Moran’s \(I\).

2. to detect cumulated area of non-suicide rate
   \(\rightarrow\) ”coolspot” of suicide rate: the hotspot of non-suicide rate

3. to compare areas between the coolspot and the hotspot
Statistics of Community for the Death from Suicide (Fujita, 2009) was updated from the Ministry of Health, Labour and Welfare demographic survey of death:

- Time: (73-77, 78-82, 83-87,) 88-92, 93-97, 98-02, 02-07 (, 08-09)
- Place: 354 Secondary medical care zones
- Sex: Male, Female
- (Age group, Ways, Marriage and Job )
Statistics of Community for the Death from Suicide

Index of Non-suicide Rate

- Non-suicide people = population - suicide people
- Non-suicide rate = Non-suicide people / population * 100,000
- Index of Non-suicide rate = Non-suicide rate - 99,900
- Expected value calculated by age group proportion and average of "Index of Non-suicide rate"
Spatial Scan Statistics

\[ H_0 : p = q \text{ v.s. } H_1 : p > q \]

where \( p = \frac{c(Z)}{e(Z)} \), \( q = \frac{c(\bar{Z})}{e(\bar{Z})} \),

\[
\max_{z \in Z} \frac{L(z)}{L_0}
\]

\( c(Z) \): Index of Non-suicide rate in \( Z \)
\( e(Z) \): Expected value in \( Z \)
\( L_0 \): Likelihood for Null Hypothesis
\( L(z) \): Likelihood for Alternative Hypothesis

Scanning method

- Circular Scan
- **Flexible Scan** → (Takahashi, et al. (2009))
- Echelon Scan
## Parameters

- **Scanning method**: Flexible Scan
  - case: Index of non-suicide rate
  - expected: Expected value calculated by age group proportion and average of "Index of non-suicide rate"
- **Statistical Model**: Poisson
- **Statistics Type**: LLR with Restriction
  - Alpha=0.2
- **Scanning Method**: Flexible
- **The Maximum Spatial Cluster Size**: 35
- **Neighborhood information**: Tomita, et al. (2010)
Results of Coolspot

Result (male in 1990)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Results of Coolspot

Color legend

- **Hotspot**
  - Most likely cluster
  - Second most likely cluster

- **Coolspot**
  - Most likely cluster
  - Candidate of most likely cluster
  - Second most likely cluster
  - Candidate of second most likely cluster

- Otherwise

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Results of Coolspot

Result (male in 1990)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Results of Coolspot

Result (male in 1995)
Results of Coolspot

Result (male in 2000)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Results of Coolspot

Result (male in 2005)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Results of Coolspot

Result (female in 1990)

Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Results of Coolspot

Result (female in 1995)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Results of Coolspot

Result (female in 2000)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Results of Coolspot

Result (female in 2005)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.

Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Results of Coolspot

Hotspots and Coolspots of Male Case in 1990

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.

Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Hotspots and Coolspots of Male Case in 1995

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.

Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Hotspots and Coolspots of Male Case in 2000

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Results of Coolspot

Hotspots and Coolspots of Male Case in 2005

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.

Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Spatio-temporal Clustering

Parameters

- Scanning method: Flexible Scan
  - case: Index of non-suicide rate
  - expected: Expected value calculated by age group proportion and average of “Index of non-suicide rate”

- Statistical Model: Poisson

- Statistics Type: LLR with Restriction
  - Alpha=0.2

- Scanning Method: Flexible

- The Maximum Spatial Cluster Size: 35

  - Spatial: Same as purely spatial neighborhood
  - Temporal: Only the same zone in previous/next time period
Result of Spatio-temporal in 1990 (male) (max=35)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Result of Spatio-temporal in 1995 (male) (max=35)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.

Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Spatio-temporal Data of Suicide in Japan

Spatio-temporal Clustering

Result of Spatio-temporal in 2000 (male) (max=35)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Result of Spatio-temporal in 2005 (male) (max=35)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Parameters

- Scanning method: Flexible Scan
  - case: Index of non-suicide rate
  - expected: Expected value calculated by age group proportion and average of ”Index of non-suicide rate”

- Statistical Model: Poisson

- Statistics Type: LLR with Restriction
  - Alpha=0.2

- Scanning Method: Flexible

- The Maximum Spatial Cluster Size: 70

  - Spatial: Same as purely spatial neighborhood
  - Temporal: Only the same zone in previous/next time period
Spatio-temporal Clustering

Result of Spatio-temporal in 1990 (male) (max=70)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Result of Spatio-temporal in 1995 (male) (max=70)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.
Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Result of Spatio-temporal in 2000 (male) (max=70)

Kubota, T., Tomita, M., Ishioka, F. and Fujita, T.

Spatial Autocorrelation Statistics and Spatial Clustering in the Areas in Japan with Low Suicide Rates
Result of Spatio-temporal in 2005 (male) (max=70)
Summary

- Time periods in male cases
  - Large areas in 2000 and 2005
  - Population effect of capital area
- Male and female (spatial cluster)
  - NOT identified significant coolspots in female cases
- Coolspots and hotspots (spatial cluster)
  - Kanto and Chukyo-Kinki areas: Coolspots
  - Tohoku and Kyushu areas: Hotspots
- Spatial and spatio-temporal clusters of coolspots
  - Large areas for coolspots in 1990 and 1995
  - Small areas for coolspots in 2000 and 2005
  - There are coolspots in 90s for Spatio-temporal clusters
- Max cluster sizes (35 and 70) in spatio-temporal clusters
  - Larger max cluster size (70) is not appropriate to detect spatio-temporal clusters of coolspots
Future Studies

- Extension for other time periods
- Definition of Neighborhood information of spatio-temporal clustering
- New index for female cases
- Reason of detected coolspot
Acknowledgement

This is a part of funded research from National Institute of Mental Health, National Center of Neurology and Psychiatry and is also partially supported by KAKENHI 21700305, KAKENHI 21700317 and KAKENHI 23500358.
REFERENCES

Thank you very much for your kind attention.

Takafumi Kubota (The Institute of Statistical Mathematics)
tkubota@ism.ac.jp