Homicide-Suicide in the State of Florida
A Cluster Analysis Using SaTScan

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TABLE OF CONTENTS

Index of Figures

Chapter I: Introduction

1.1 What is Homicide-Suicide?

A homicide which is followed by a suicide is a rare and deadly event in which a person kills another and then commits suicide shortly after the homicide. As one medical professional states, "because many murder-suicides result in the death or injury of family members and sometimes mass murder, they cause countless additional morbidity, family trauma and disruption for communities." [1] Although this tragedy is uncommon, it still accounts for an average of 554 cases a year in the United States. This represents about .03% of all homicides. Relatively little statistical analysis of this incident is available, partly due to a lack of a national database or tracking system in the United States. National crime databases such as the Supplemental Homicide Report and the National Vital Statistics System do not link homicide to suicide events. With nationwide data unavailable, researchers must rely on police and medical examiner records and newspaper clipping searches to obtain viable information for study. [2] The Institute of Medicine Suicide Prevention report also noted that the data reported by the coroner's office is often unreliable due to regional differences in the requirements for the position of coroner, the definition and classification of suicide, background and training and the quality of data management. [3] In addition, there is a relatively small amount of research on homicide-suicides due to the social organization of research on homicides and suicides. While researchers of criminology focus on homicides, public health researchers focus on suicides. Currently, Dr. F. Stephen Bridges, Professor of Community Health Education at The University of West Florida, is conducting an extensive study of homicide-suicide in the state of Florida for the 1990-2007 time period. This ground-breaking research will provide the first detailed study of this

phenomenon in the state. This proseminar study is the initial statistical analysis of the data which Dr. Bridges has compiled thus far in his study.

1.2 Homicide-Suicide Statistics

Epidemiological studies of the homicide-suicides provide many interesting results about the victims, the offenders and the methods of the crimes. In a study of 2215 victims in homicide-suicides in the United States from 1968-1975, it was shown that 79% of the homicide victims in homicide-suicides were women. This fact is contrasted with the fact that men are more often the victims of homicides, excluding those in homicide-suicides. When the ages of the victims in homicide-suicide were considered, researchers found that for the 258 victims under the age of 15 years, 52% were female and for the 1915 victims over the age of 15 years, 83% were female. This indicates that when the victim is young, the victim is as likely to be a girl as a boy, but when the victim is an adult, it is overwhelmingly a woman.

In the same study, it was shown that the offender who commits the homicide followed by their own suicide is the husband killing his wife in 51% of instances while the wife kills her husband in 5% of cases. In 13% of the studied incidents, the parent killed a child while 10% involved a love triangle and 8% other arguments. When the crime included the murder of a child, the offender was more likely to be female (87%) than male (41%) [2]. Studies have shown that women are more likely to kill their children and then themselves, but not their intimate partner. When a man is the offender, he will kill the children and the intimate partner before ending his own life. [1]

Studies to compare the incidence rate of homicide-suicide by age group have shown a higher base rate for the individuals over 55 than those 54 and under. One such study in Florida documented an annual incidence rate of 0.4 to 0.9 per 100,000 for persons age 55 and older and

0.3 to 0.7 per 100,000 for persons under age 55. In many cases, information about the older couples suggest that both the offender and the victim were ill or in failing health. Also, mental health problems were present in most perpetrators. [3] One study which examined rates of homicide-suicide in the United States found that spousal homicide-suicides by offenders aged 55 and over comprise at least one-third of the total annual deaths due to homicide-suicide. [4] Although homicide-suicides are a rare relative to the number of suicides, it has been suggested that future research is important to determine if the rates are increasing especially among the elderly. People over the age of 65 rarely commit homicide, but their rate for suicide is the highest for any age group. A report from the Center for Disease Control showed a greater increase in the suicide rate for the over-age 65 population especially in Florida. [3]

When the method for the homicide is studied, the victim of homicide-suicide is much more likely to be shot by any type of firearm than with any other homicide. Specifically, handguns were used by male murderers for approximately 90% of the murders, while handguns were used by 69% of female murderers. [2] One study of homicide-suicide in intimate partner relationships showed that access to a firearm was one of the most important factors differentiating victims of fatal versus nonfatal partner violence and distinguishing between homicide-suicides and simple homicides. The study suggests that improved enforcement of the laws aimed at keeping firearms out of the hands of domestic abusers might prevent not only intimate partner homicides but suicides as well. [5]

Chapter II: Data and Methodology

2.1 Homicide-Suicide Data Collection

Dr. Bridges obtained mortality data from the Office of Vital Statistics at the FL Department of Health. The mortality data were taken from death certificates for all non-natural causes of death with only homicide and suicide decedents kept behind. Decedents as a result of accidents and other non-natural causes were removed. Then, data matching techniques were employed to obtain duplicates for select variables, such as last name, date of death, and street address. Decedents identified as having a duplicate variable(s) were then examined to make sure one decedent died as a result of a homicide and one as a result of a suicide. Only follow-up newspaper surveillance data could confirm the suspected link of a homicide to a suicide, i.e., homicide-suicide. The resulting 457 homicide-suicides for the years 1990-2007 were then sorted to determine the number of homicide-suicides which occurred in each of the 67 counties in Florida in each year of the study.

2.2 SaTScan Methodology

In 1997, Dr. Martin Kulldorff, Associate Professor and Biostatistician of the Department of Population Medicine at Harvard Medical School developed the first version of the spatial scanning model called SaTScan. Now in its 9^{th} version, SaTScan is a free software which analyzes spatial, temporal and space-time data using the spatial, temporal, or space-time scan statistics. SaTScan has been widely used in the geographical surveillance of diseases, most notably cancer, such that spatial and space time disease clusters could be identified. This software has applications in many fields other than the spatial study of disease, but its use as a tool for analyzing the spatial dimensions of homicide-suicide is the focus of this study. To date, relatively little large scale crime analysis has been conducted using SaTScan. Crime cluster

identification and statistical analysis is an important tool in law enforcement since the identification of crime patterns enables these agencies to more effectively focus their enforcement and well as prevention efforts [6].

SaTScan is able to determine if and where statistical clusters exist by using a variety of statistical models, such as the Normal, Binomial, and Poisson models. The choice of model is dependent upon the available data. For this study with discrete count data, the Poisson discrete model was the best choice since an incident count was available for the associated population. The Poisson model is given by:

$$P_x(x) = P(x = k) = \frac{e^{-k}\lambda^k}{k!}$$

Where: k=actual occurrences and λ = expected number of occurrences

Clusters are determined by a comparison of the expected and observed number of cases within and outside a scanning window that has a varying radius and center. The comparison is called the Likelihood Ratio, and it determines how likely a cluster is to be due to more than chance. Thus, the higher the Likelihood Ratio (LR), the more likely that particular cluster is due to more than chance alone. The likelihood ratio (LR) is given by:

$$\boldsymbol{LR = (\frac{n}{E})^n (\frac{N-n}{N-E})^{N-n}} \quad \mathbf{I()}$$

Where: n = number of counts in the scanning window, N = total number of counts outside the window and I () = the indicator function. I = 1 when p > q, the null hypothesis is false, the scan window has a larger # of homicide-suicides than expected and I= 0 when p=q, the null hypothesis is true. This analysis is a one-tailed hypothesis test where $(\frac{n}{E})^n$ is the probability of homicide-suicides inside a particular region (scan window) and $(\frac{N-n}{N-E})^{N-n}$ is the probability of

homicide-suicides outside the region (total arrests outside window). P-values are assigned to each cluster, in order to show the statistical significance of the finding. Monte-Carlo simulations decide these p-values as SaTScan creates random simulations of the data, and then shows how many of those simulations resulted in higher likelihood ratios than what the actual data found. That number is used to calculate the p value which is given by:

$$p = \frac{R}{1 + \#\text{ of simulations}}$$

where R is the rank when the user selects the number of simulations. In order for p to be a 'nice looking' number, the number of simulations is restricted to 999 or some other number ending in 999 such as 1999, 9999 or 99999. That way it is always clear whether to reject or not reject the null hypothesis for typical cut-off values such as 0.05, 0.01 and 0.001. The program assumes a null hypothesis of random distribution rates across the entire area; therefore, a small p value would indicate a significant cluster. The scanning window with the maximum likelihood ratio is flagged as the most likely or primary cluster and the log likelihood ratio (LLR) is reported. The primary cluster and the secondary clusters, which are ordered according to their likelihood ratio, are then noted. Maps may be created to clearly represent the location and size of the clusters so that the casual observer can readily interpret the data. [7]

2.3 SaTScan Input

SaTScan requires different input fields in order to analyze the data. The first input file is the case file. For this study, the case file was the number of homicide-suicides in a county for a particular year. The second input file is the population file. This file listed the population of each county for each of the eighteen years of the study. The data was obtained by the United

States Census Bureau Intercensal Data records. The last filed needed was the latitude/longitude coordinates for each county. These coordinates are not the actual center of the county, but rather the population centroid of each county.

SaTScan has several options including one that allows a choice of the maximum size cluster reported. The default cluster size is 50% of the population. The user may change this value, but for this study, the default setting was used. Therefore, the maximum cluster size reported will be no more than the total population of Florida.

Chapter III: Results

3.1 SatScan Results

The homicide-suicide data consisted of 457 total cases in the 67 counties in Florida during the 18 year period from 1990–2007. The SaTScan analysis of the purely spatial case was performed first for all the counties for the entire study period of 1999-2007. Then, the separate time periods of 1990-2000 and 2000-2007 were run using only the spatial analysis. Finally, using the space-time option in SaTScan, the data from 1990-2007 was analyzed, thus visiting the data for each year of the study and detecting homicide suicide clusters that may have only existed for a year or more, but may not have appeared to be clusters when the entire eighteen year period was studied.

3.1.1 Purely Spatial

The SaTScan purely spatial analysis revealed a twelve county cluster in Central Florida for the period 1990-2007. (Figure 1) The relative risk for this cluster of 1.47 indicates that the likelihood of a homicide-suicide in this region is 47% higher than the regions in Florida outside

this cluster for this time period. The p-value of 0.027 was less the designated $\alpha = 0.05$ level of significance, indicating that there is a 2.7 % probability that the cluster is due to chance.

Figure 1: SaTScan results for Purely Spatial 1990-2007

Purely Spatial analysis
scanning for clusters with high rates
using the Discrete Poisson model.

SUMMARY OF DATA

Study period.....: 1990/1/1 to 2007/12/31
Number of locations.....: 67
Total population.....: 15664011
Total number of cases.....: 457
Annual cases / 100000.....: 0.2

MOST LIKELY CLUSTER

1.Location IDs included.: FLLake, FLSumter, FLSeminole,
FLOrange, FLMarion, FLOsceola,
FLCitrus, FLVolusia, FLHernando,
FLPolk, FLPutnam, FLPasco
Coordinates / radius..: (28.771594 N, 81.756071 W) / 94.87 km
Population.....: 3501098
Number of cases.....: 136
Expected cases.....: 102.15
Annual cases / 100000.: 0.2
Observed / expected...: 1.33
Relative risk.....: 1.47
Log likelihood ratio..: 6.745452
P-value.....: 0.027

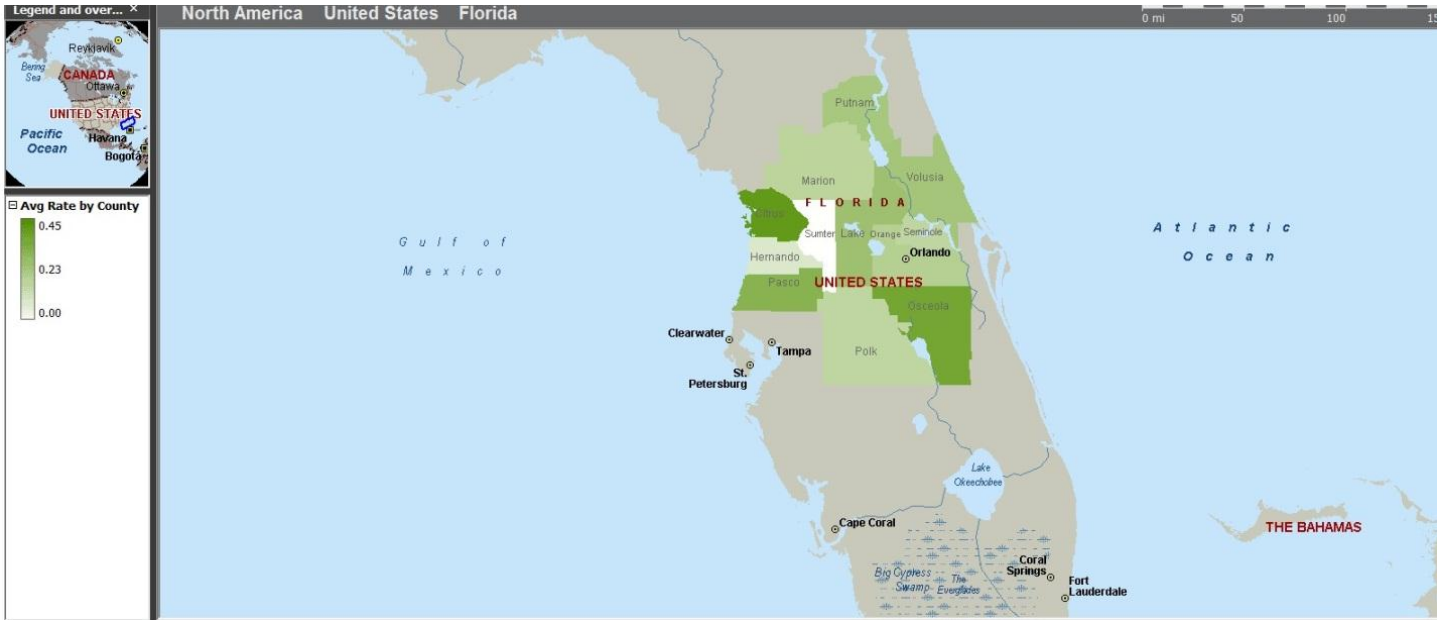
The purely spatial analysis for the shorter period 1990-2000 did not result in a significant cluster, while the 2000-2010 time period indicated a similar Central Florida cluster as the 1990-2007 time periods, yet its p-value of 0.057 was not within the 0.05 level of significance; therefore, it will not be considered.

3.1.2 Time-Space

The Space-Time analysis for 2000-2007 did show a one county cluster (Citrus County 2003-2005), but it's p-value of 0.069 is not within our chosen level of significance $\alpha = 0.05$ The Space-Time analyses for the periods 1990-2000 and 1990-2007 did not produce any homicide suicide clusters near the level of significance.

3.2 Homicide-Suicide Annual Rate (Cluster Counties)

Next, the annual suicide rate was calculated for each county within the Purely Spatial cluster. These annual rates were averaged for the 18 year period of study to produce a map to more clearly detail the counties within the cluster with the highest proportion of homicide-suicides per year. (Figure 2) The darker counties correspond to the higher rates. It is important to note that Sumter County in the center of the cluster had no homicide-suicides, yet it is included in the 12 county cluster. This is due to the fact that in the SaTScan program, clusters are determined by a comparison of the expected and the observed number of observed cases within and outside a scanning window that has a varying radius. Since this county is small and surrounded by larger counties with higher incident rates, it fell into the cluster. The next stage of this study will break the data into the smaller geographical regions to refine the cluster area.



Citrus	Hernando	Lake	Marion	Orange	Osceola
0.41022	0.088951	0.253344	0.179001	0.190483	0.36704
Pasco	Polk	Putnam	Seminole	Sumter	Volusia
0.310725	0.160823	0.228967	0.167417	0	0.242772

Per 100,000

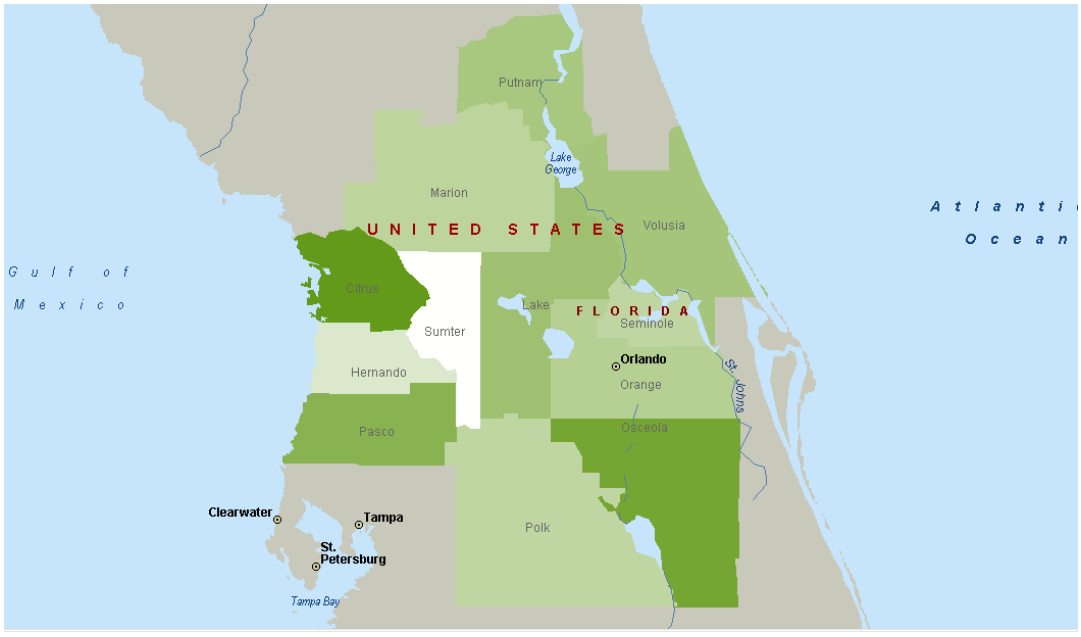


Figure 2 Average Annual Rate of Homicide Suicide for Counties in 1990-2007 Purely Spatial Cluster

Next, the entire twelve county cluster was considered as one group, while the remaining 55 counties in Florida outside the cluster were considered as a second group. The number of homicide-suicides was totaled for both groups for each year of the study. The proportion for each year was found by dividing the number of incidences in the group by the total population of the group for the year. (Figure 3) The counties inside the cluster had homicide-suicides occur for a greater proportion of the population for fifteen of the eighteen year study period.

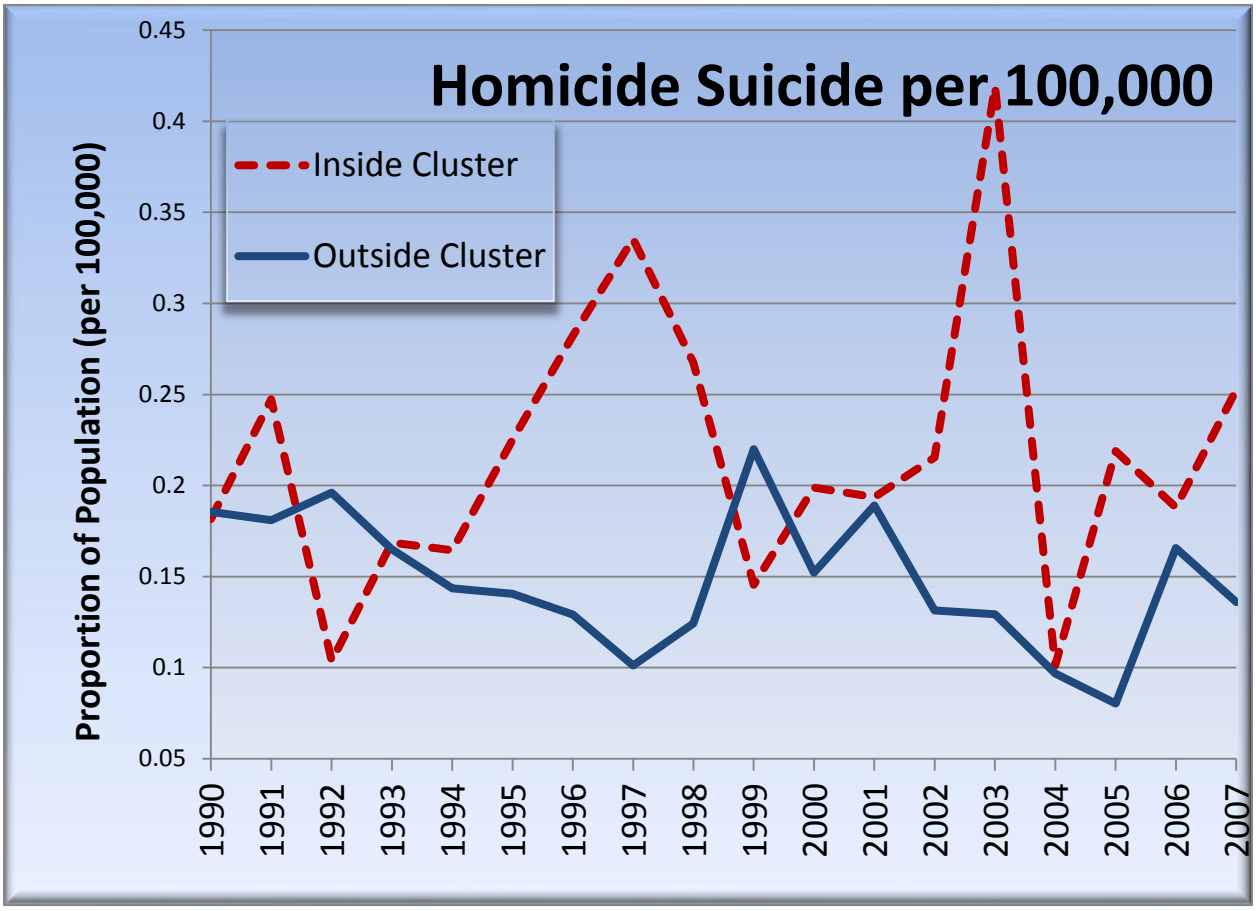


Figure 3: Proportion of Homicide-Suicide for Counties Inside and Outside the Cluster

3.3 Demographic Analysis (Cluster Counties)

Data was then collected for each county in Florida to study demographic factors which may influence the incidence of homicide-suicide. The factors to be studied were median income, population density and percentage of the population over age 65. Median income and population density were chosen to determine if the homicide-suicide could be more prevalent in areas with lower (or higher) income and higher (or lower) population density. Since research has suggested an elevated risk of homicide-suicide for the elderly population, the age group 65 and over was also studied. For each of these potential influences, the difference between the factor within the twelve county cluster and outside the cluster was analyzed.

Population density was found to about the same in 1990, but by 2007, the population density within the cluster counties increased to approximately 16% higher than the Florida counties outside the cluster. (Figure 4)

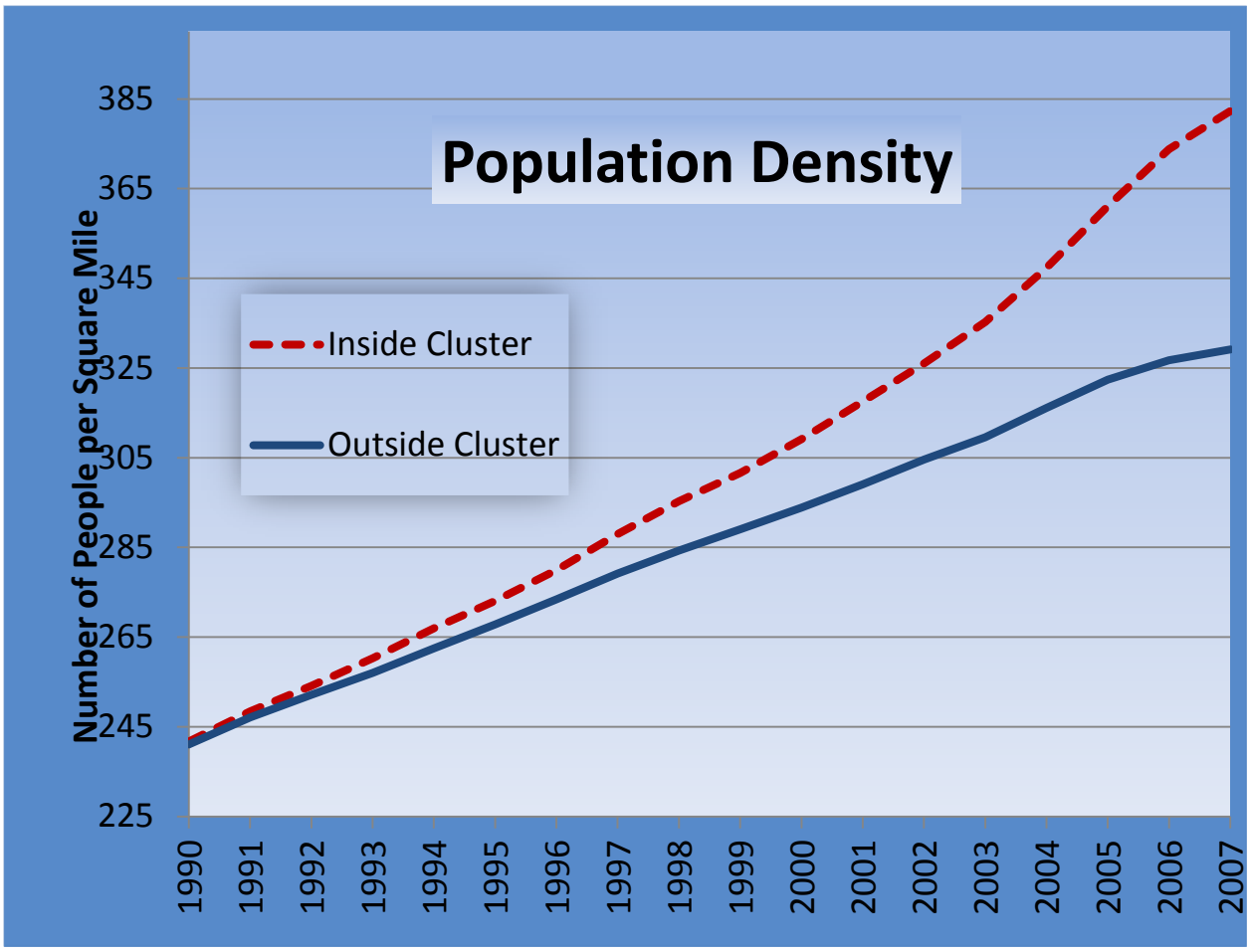


Figure 4: Population Density for Counties Inside and Outside the Cluster

The population of residents inside the cluster over age 65 and those outside the cluster over age 65 were compared. The proportion of the population inside the cluster over the age of 65 was approximately 1.5% higher than the population outside the cluster. (Figure 5)

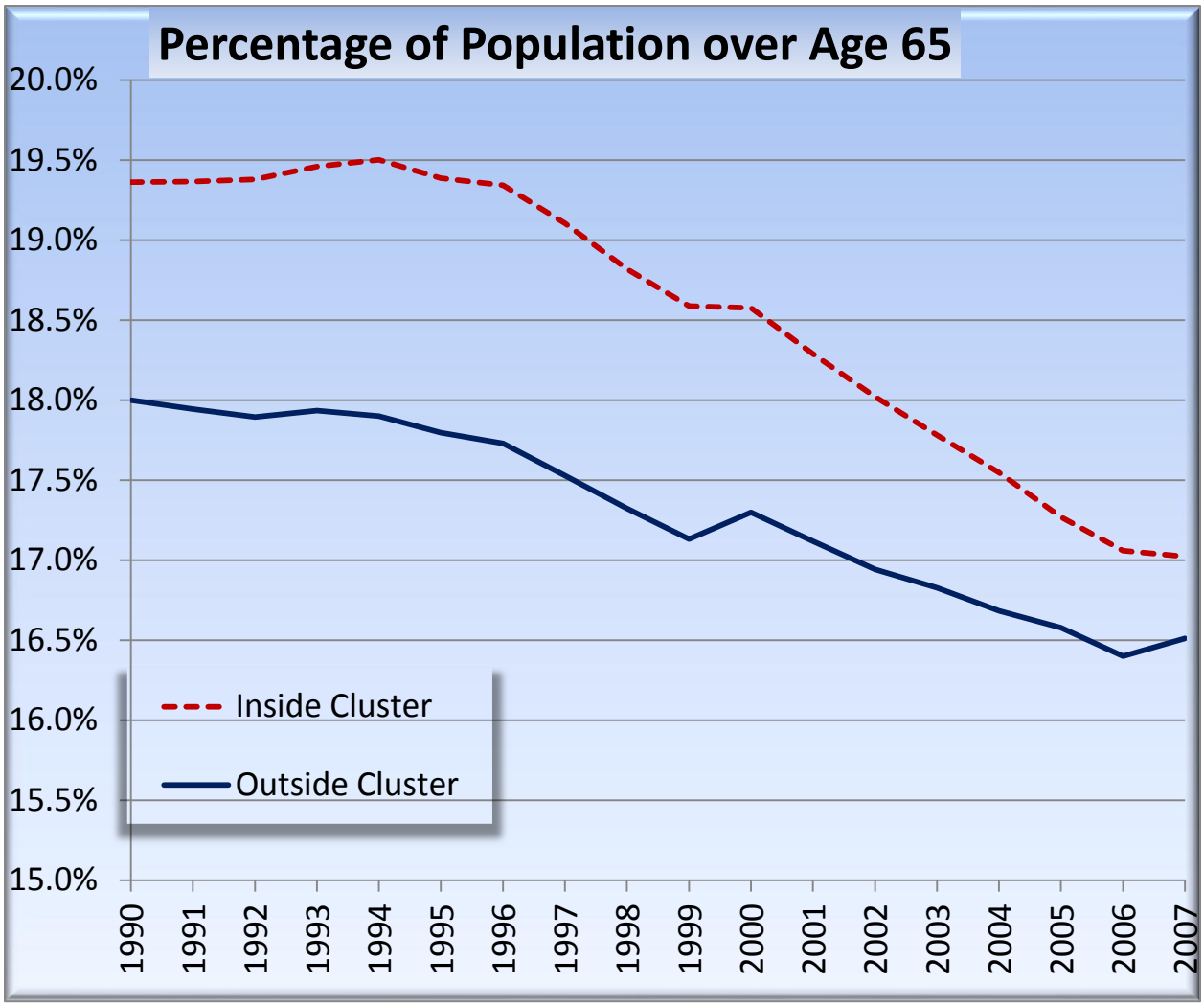


Figure 5: Proportion of Population over Age 65 Inside and Outside the Cluster

A comparison of median income for the population inside the cluster counties and outside the cluster counties was made. The median income outside the cluster counties was consistently higher than the counties inside the cluster with a difference of approximately 13%. (Figure 6)

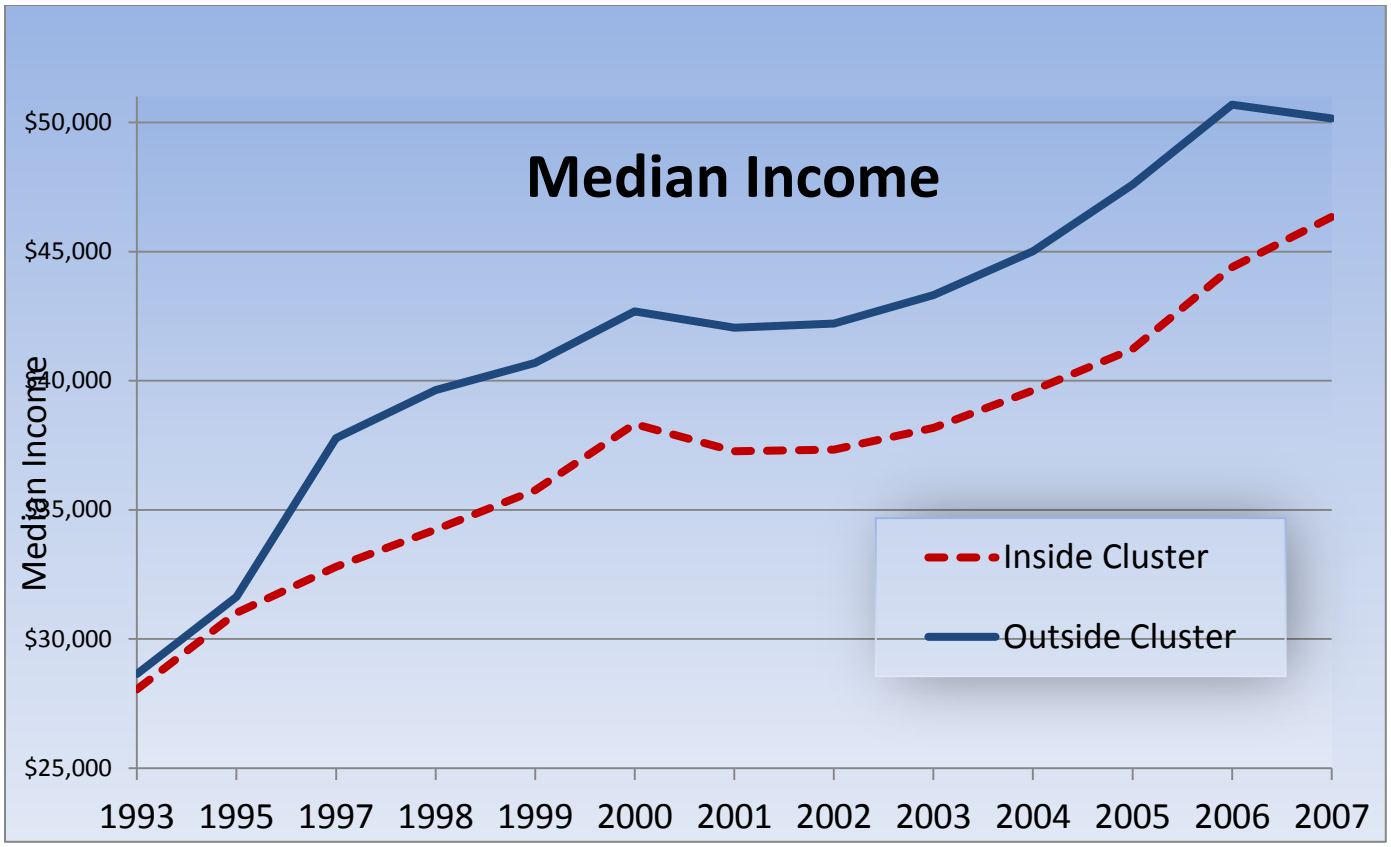


Figure 6: Average Median Income Inside and Outside the Cluster

Chapter IV: Covariate Adjustment

A covariate is a variable that the experimenter cannot control but can only observe. According to the SaTScan User Guide [7], covariate adjustments in SaTScan should be made if the all of the three following are valid:

- The covariate is related to the disease/crime in question.
- The covariate is not randomly distributed geographically.
- You want to find clusters that cannot be explained by that covariate.

When adjustments are made for these covariates, SaTScan looks for clusters beyond what is anticipated from these covariates. Since the factors of population density, proportion of population over 65 and median income appear to be not randomly distributed and may be related

to homicide-suicide, an additional analysis was performed to look for clusters which are not driven by these factors.

4.1 Covariate Adjustment Using Statistical Regression Software

According to the SaTScan Users Guide [7], "SaTScan cannot in itself do an adjustment for continuous covariates. Such adjustments can still be done for the Poisson model, but it is a little more complex. The first step is to calculate the covariate adjusted expected number of cases for each location ID and time using a standard statistical regression software package like SAS. These expected numbers should then replace the raw population numbers in the population file, while not including the covariates themselves." Using SAS, the predicted values were calculated and then used in place of the county population numbers for the SaTScan analysis. This procedure was done for each of the three covariates.

4.2 Covariate Adjustment Results

4.2.1 Population Density (Purely Spatial 1990-2007)

The results of the covariate adjustment for population density showed a 24 county cluster of homicide-suicide including 6 of the original cluster counties. Since this cluster covers over a third of the state, it does not provide useful information on the relationship between population density and homicide-suicide.

4.2.2 Proportion of Population Over Age 65 (Purely Spatial 1990-2007)

When the covariate adjustment to SaTScan was done for the proportion of the population over 65, we found that 11 of the 12 original cluster counties appeared in the new 14 county cluster including the two new counties of Brevard and Hillsborough. This result shows that after removing the differences in population age between the 67 counties in Florida, the remaining

counties in the homicide-suicide cluster of the 12 original counties was not driven by advanced age of its population.

4.2.3 Median Income (Purely Spatial 1997-2007)

With more significant differences in median income between the original 12 cluster counties and the counties outside the cluster observed, the covariate adjustment was made for median income in SaTScan. Since median income data was available for all of the counties for the period 1997-2007, this eleven year period was chosen. The SaTScan results showed that all of the 12 counties in the cluster disappeared and a new significant cluster in Broward and Miami Dade County appeared. (Figure 7) This showed that by adjusting for income, all differences between the 67 counties were removed with respect to median income, and the resulting cluster is not associated with income of the population. We conclude that the original 12 county cluster which vanished was driven by a lower median income.

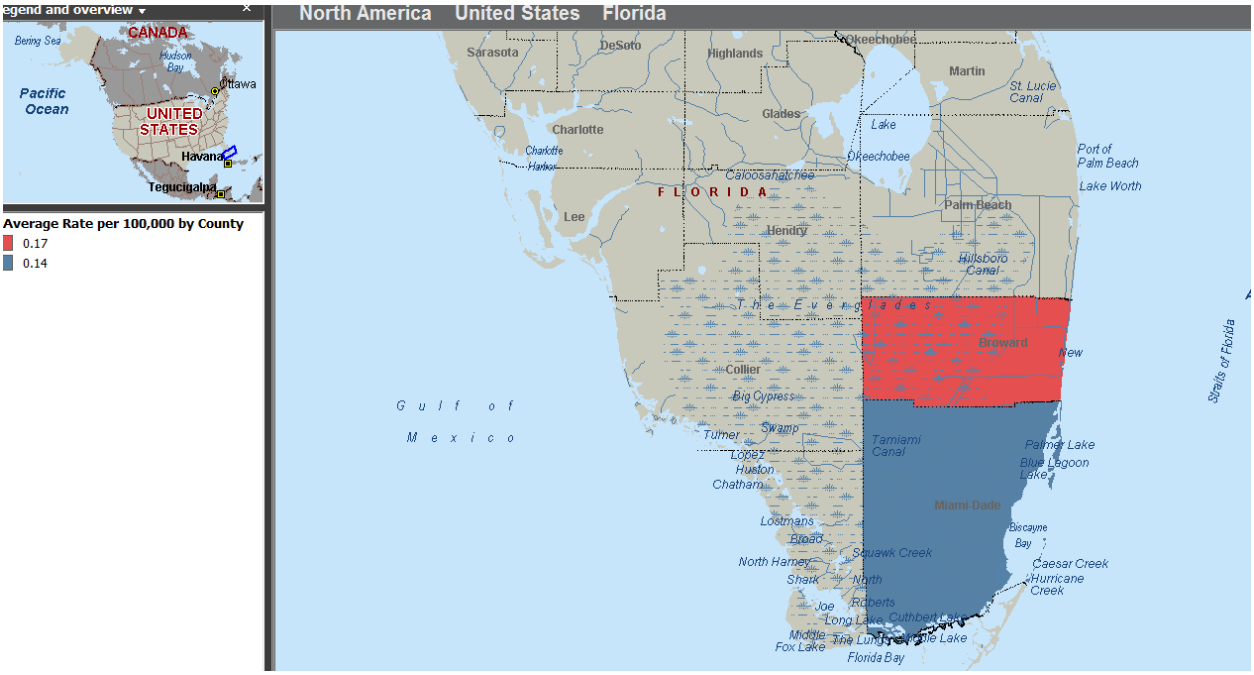


Figure 7: Cluster Resulting from Covariate Adjusted SaTScan (for Median Income)

Chapter V: Conclusion

5.1 Summary of Results

This initial study of the homicide-suicide data from Dr. F. Stephen Bridges for the state of Florida for 1990-2007 indicates that a larger than expected number of homicide-suicides take place in eleven central Florida counties than in the other counties in the state. Citrus County with 0.41 homicide-suicides per 100,000 residents is the county with the highest incident average rate. The proportion of the population which experienced a homicide-suicide within the cluster counties (including Sumter) is higher than the counties outside the cluster for 15 of the 18 years. While this cluster is large, we are able to see that this area does differ from the rest of Florida on several demographic factors. The population density (number of people per square mile) difference grew to 16% for the counties within the cluster when compared to those outside the by 2007. The proportion of the population over age 65 is greater in the cluster by approximately 2%. The median income within the cluster counties was lower than the non-cluster counties with an average difference of 13 %.

When adjustments to the SaTcan analysis were made for the three covariates of population density, proportion over age 65 and median income, it was found that the only covariate that drove the homicide-suicide elevated rates in the 12 county central Florida cluster is median income. When differences in income are removed, the primary cluster is in South Florida in the counties of Broward and Miami Dade. We conclude that the lower median income in the central Florida counties is an important factor in the elevated number of homicide-suicides.

5.2 Limitations of the Study

As Dr. Bridges is currently compiling and corroborating the data, this proseminar is the result of the data that was made available for analysis in mid-October. The remaining data for 2008-2010 as well as the more geographically detailed data at the zip code level will be forthcoming.

5.3 Suggestions for Future Study

This study will be ongoing with the next step consisting of SaTScan analysis on the homicide-suicide data at the zip code level to provide a more geographically detailed picture of where the clusters are located. Covariate adjustment will be added to the zip-code level analysis since covariates are factors that could affect the outcome of the results. Also, the remaining data for the final years of the study 2008-2011 will be added to the study.

LITERATURE REFERENCES

[1] Violence Policy Center. American Roulette – Murder Suicide in the United States, May 2006

[2] Bridges, F. Stephen, Lester, David. Homicide – Suicide in the United States 1968-1975, *Forensic Science International*, September 1, 2010

[3] Bell, Carl C.; McBride, Dominica F.. Commentary: Homicide-Suicide in Older Adults – Cultural and Contextual Perspectives, *The Journal of the American Academy of Psychiatry and the Law*, Volume 38, Number 3, 2010

[4] Bourget, Dominique; Gagne, Pierre; Whitehurst, Laurie. Domestic Homicide and Homicide-Suicide: The Older Offender, The *Journal of American Academy of Psychiatry and Law*, Volume 38, Number 3, 2010

[5] Barber, Catherine W.; Azrael, Deborah; Hemenway, David; Olson, Lenora; Nie, Carrie; Schaechter, Judy; Walsh, Sabrina; Suicides and Suicide Attempts Following Homicide: Victim Suspect Relationship, Weapon Type, and Presence of Antidepressants, *Homicide Studies*, 2008

[6] Wilson, Ronald E. The Impact of Software on Social Science, *Computer Review* , Volume 25 Number 2, Summer 2007: 135–142

[7] Kulldorff, Martin (1997). SaTScan software and bibliography website: http://satscan.org/references.html

DATA REFERENCES

U. S. Census Bureau, Small Area Incomes and Poverty Estimates http://www.census.gov/did/www/saipe/county.html

Florida Department of State, Division of Library and Information Services, Land and Water Area by Florida County http://dlis.dos.state.fl.us/library/flcollection/landWater.cfm

U. S. Census Bureau Population Estimates (1990-2000) http://www.census.gov/popest/archives/2000s/vintage_2001/CO-EST2001-12/CO-EST2001-12-12.html

U. S. Census Bureau Population Estimates (2000-2010) http://www.census.gov/popest/intercensal/county/CO-EST00INT-01.html

Florida Population Estimates by Age http://www.floridacharts.com/FLQuery/Population/PopulationRpt.aspx

SaTScan Output

SaTScan v9.1.1

Program run on: Sat Oct 22 00:16:10 2011

Purely Spatial analysis
scanning for clusters with high rates
using the Discrete Poisson model.

SUMMARY OF DATA

Study period.....: **1990/1/1 to 2000/12/31**
Number of locations.....: 67
Total population.....: 14554993
Total number of cases.....: 270
Annual cases / 100000.....: 0.2

MOST LIKELY CLUSTER

1.Location IDs included.: FLHillsborough, FLPinellas, FLPasco, FLManatee, FLHernando, FLPolk, FLHardee, FLSarasota, FLSumter, FLCitrus, FLDesoto, FLOsceola, FLLake, FLHighlands
  Coordinates / radius..: (27.983120 N, 82.410617 W) / 111.88 km
  Population.....: 3824071
  Number of cases.....: 93
  Expected cases.....: 70.94
  Annual cases / 100000.: 0.2
  Observed / expected...: 1.31
  Relative risk.....: 1.47
  Log likelihood ratio..: 4.392266
  P-value.....: 0.254

SECONDARY CLUSTERS

2.Location IDs included.: FLBroward, FLMiamiDade, FLPalmBeach
  Coordinates / radius..: (26.138850 N, 80.220032 W) / 52.83 km
  Population.....: 4550231
  Number of cases.....: 97
  Expected cases.....: 84.41
  Annual cases / 100000.: 0.2
  Observed / expected...: 1.15
  Relative risk.....: 1.23
  Log likelihood ratio..: 1.332836
  P-value.....: 0.990

Program run on: Fri Oct 21 08:27:26 2011

Purely Spatial analysis
scanning for clusters with high rates
using the Discrete Poisson model.

SUMMARY OF DATA

Study period.....: **2000/1/1 to 2007/12/31**
Number of locations.....: 67
Total population.....: 17237041
Total number of cases.....: 213
Annual cases / 100000.....: 0.2

MOST LIKELY CLUSTER

1.Location IDs included.: FLSeminole, FLOrange, FLLake,
FLOsceola, FLVolusia, FLSumter,
FLBrevard, FLPolk, FLFlagler,
FLMarion, FLPutnam, FLCitrus,
FLHernando, FLPasco
Coordinates / radius..: (28.693009 N, 81.316725 W) / 128.60 km
Population.....: 4537215
Number of cases.....: 79
Expected cases.....: 56.07
Annual cases / 100000.: 0.2
Observed / expected...: 1.41
Relative risk.....: 1.65
Log likelihood ratio..: 5.920004
P-value.....: 0.057

SECONDARY CLUSTERS

2.Location IDs included.: FLMonroe
Coordinates / radius..: (24.742865 N, 81.248599 W) / 0 km
Population.....: 76985
Number of cases.....: 4
Expected cases.....: 0.95
Annual cases / 100000.: 0.6
Observed / expected...: 4.20
Relative risk.....: 4.27
Log likelihood ratio..: 2.718180
P-value.....: 0.751

NOTE: The sequential Monte Carlo procedure was used to terminate
the calculations after 876 replications.

Program run on: Thu Oct 20 22:46:03 2011

Purely Spatial analysis
scanning for clusters with high rates
using the Discrete Poisson model.

SUMMARY OF DATA

Study period.....: **1990/1/1 to 2007/12/31**
Number of locations.....: 67
Total population.....: 15664011
Total number of cases.....: 457
Annual cases / 100000.....: 0.2

MOST LIKELY CLUSTER

1.Location IDs included.: FLLake, FLSumter, FLSeminole,
FLOrange, FLMarion, FLOsceola,
FLCitrus, FLVolusia, FLHernando,
FLPolk, FLPutnam, FLPasco
Coordinates / radius..: (28.771594 N, 81.756071 W) / 94.87 km
Population.....: 3501098
Number of cases.....: 136
Expected cases.....: 102.15
Annual cases / 100000.: 0.2
Observed / expected...: 1.33
Relative risk.....: 1.47
Log likelihood ratio..: 6.745452
P-value.....: 0.027

SaTScan v9.1.1

Program run on: Sat Oct 22 00:21:06 2011

Retrospective **Space-Time analysis**
scanning for clusters with high rates
using the Discrete Poisson model.

SUMMARY OF DATA

Study period..................: **1990/1/1 to 2000/12/31**
Number of locations...........: 67
Total population..............: 14554993
Total number of cases.........: 270
Annual cases / 100000.........: 0.2

MOST LIKELY CLUSTER

1.Location IDs included.: FLHardee, FLHighlands, FLDesoto
  Coordinates / radius..: (27.551158 N, 81.813841 W) / 40.48 km
  Time frame............: 1990/1/1 to 1991/12/31
  Population............: 131917
  Number of cases.......: 4
  Expected cases........: 0.39
  Annual cases / 100000.: 1.7
  Observed / expected...: 10.27
  Relative risk.........: 10.41
  Log likelihood ratio..: 5.731684
  P-value...............: 0.72

SECONDARY CLUSTERS

2.Location IDs included.: FLOsceola
  Coordinates / radius..: (28.273774 N, 81.373812 W) / 0 km
  Time frame............: 1998/1/1 to 1999/12/31
  Population............: 140905
  Number of cases.......: 4
  Expected cases........: 0.55
  Annual cases / 100000.: 1.2
  Observed / expected...: 7.26
  Relative risk.........: 7.35
  Log likelihood ratio..: 4.500467
  P-value...............: 0.94

NOTE: The sequential Monte Carlo procedure was used to terminate
      the calculations after 69 replications.

Program run on: Fri Oct 21 08:41:53 2011

Retrospective **Space-Time analysis**
scanning for clusters with high rates
using the Discrete Poisson model.

SUMMARY OF DATA

Study period.....: **2000/1/1 to 2007/12/31**
Number of locations.....: 67
Total population.....: 17237041
Total number of cases.....: 213
Annual cases / 100000.....: 0.2

MOST LIKELY CLUSTER

1.Location IDs included.: FLCitrus
  Coordinates / radius..: (28.859855 N, 82.450973 W) / 0 km
  Time frame.....: 2003/1/1 to 2005/12/31
  Population.....: 129005
  Number of cases.....: 6
  Expected cases.....: 0.60
  Annual cases / 100000.: 1.5
  Observed / expected...: 9.96
  Relative risk.....: 10.22
  Log likelihood ratio..: 8.461128
  P-value.....: 0.069

SECONDARY CLUSTERS

2.Location IDs included.: FLBrevard, FLOsceola, FLIndianRiver,
                          FLOrange, FLSeminole, FLVolusia
  Coordinates / radius..: (28.243580 N, 80.688453 W) / 102.23 km
  Time frame.....: 2002/1/1 to 2003/12/31
  Population.....: 2712826
  Number of cases.....: 20
  Expected cases.....: 8.13
  Annual cases / 100000.: 0.4
  Observed / expected...: 2.46
  Relative risk.....: 2.61
  Log likelihood ratio..: 6.487685
  P-value.....: 0.358

3.Location IDs included.: FLMonroe
  Coordinates / radius..: (24.742865 N, 81.248599 W) / 0 km
  Time frame.....: 2001/1/1 to 2004/12/31
  Population.....: 76985
  Number of cases.....: 4
  Expected cases.....: 0.48

```
  Annual cases / 100000.: 1.3
  Observed / expected...: 8.25
  Relative risk.........: 8.39
  Log likelihood ratio..: 4.956813
  P-value...............: 0.800

4.Location IDs included.: FLFlagler, FLPutnam
  Coordinates / radius..: (29.525009 N, 81.223269 W) / 48.68 km
  Time frame............: 2006/1/1 to 2006/12/31
  Population............: 140925
  Number of cases.......: 3
  Expected cases........: 0.25
  Annual cases / 100000.: 1.9
  Observed / expected...: 12.24
  Relative risk.........: 12.40
  Log likelihood ratio..: 4.776280
  P-value...............: 0.854

5.Location IDs included.: FLWalton, FLOkaloosa, FLHolmes,
                          FLWashington, FLBay, FLSantaRosa
  Coordinates / radius..: (30.616203 N, 86.177707 W) / 83.39 km
  Time frame............: 2000/1/1 to 2000/12/31
  Population............: 557392
  Number of cases.......: 4
  Expected cases........: 0.80
  Annual cases / 100000.: 0.8
  Observed / expected...: 4.98
  Relative risk.........: 5.05
  Log likelihood ratio..: 3.246726
  P-value...............: 0.993

6.Location IDs included.: FLCharlotte, FLDesoto, FLSarasota
  Coordinates / radius..: (26.958364 N, 82.117828 W) / 44.28 km
  Time frame............: 2007/1/1 to 2007/12/31
  Population............: 538820
  Number of cases.......: 4
  Expected cases........: 0.88
  Annual cases / 100000.: 0.7
  Observed / expected...: 4.56
  Relative risk.........: 4.62
  Log likelihood ratio..: 2.966946
  P-value...............: 0.997

NOTE: The sequential Monte Carlo procedure was used to terminate
      the calculations after 720 replications.
```

Program run on: Thu Oct 20 22:49:18 2011

Retrospective **Space-Time analysis**
scanning for clusters with high rates
using the Discrete Poisson model.

SUMMARY OF DATA

Study period.....: **1990/1/1 to 2007/12/31**
Number of locations.....: 67
Total population.....: 15664011
Total number of cases.....: 457
Annual cases / 100000.....: 0.2

MOST LIKELY CLUSTER

1.Location IDs included.: FLCitrus
  Coordinates / radius..: (28.859855 N, 82.450973 W) / 0 km
  Time frame.....: 2003/1/1 to 2005/12/31
  Population.....: 116192
  Number of cases.....: 6
  Expected cases.....: 0.63
  Annual cases / 100000.: 1.5
  Observed / expected...: 9.49
  Relative risk.....: 9.60
  Log likelihood ratio..: 8.164038
  P-value.....: 0.193

SECONDARY CLUSTERS

2.Location IDs included.: FLHardee, FLHighlands, FLDesoto
  Coordinates / radius..: (27.551158 N, 81.813841 W) / 40.48 km
  Time frame.....: 1990/1/1 to 1991/12/31
  Population.....: 140495
  Number of cases.....: 4
  Expected cases.....: 0.37
  Annual cases / 100000.: 1.7
  Observed / expected...: 10.69
  Relative risk.....: 10.77
  Log likelihood ratio..: 5.864782
  P-value.....: 0.830

3.Location IDs included.: FLBrevard, FLOsceola, FLIndianRiver,
                          FLOrange, FLSeminole, FLVolusia
  Coordinates / radius..: (28.243580 N, 80.688453 W) / 102.23 km
  Time frame.....: 2003/1/1 to 2003/12/31
  Population.....: 2425282
  Number of cases.....: 13
  Expected cases.....: 4.32

```
  Annual cases / 100000.: 0.5
  Observed / expected...: 3.01
  Relative risk.........: 3.07
  Log likelihood ratio..: 5.733948
  P-value...............: 0.849

4.Location IDs included.: FLMonroe
  Coordinates / radius..: (24.742865 N, 81.248599 W) / 0 km
  Time frame............: 2001/1/1 to 2004/12/31
  Population............: 78951
  Number of cases.......: 4
  Expected cases........: 0.51
  Annual cases / 100000.: 1.3
  Observed / expected...: 7.87
  Relative risk.........: 7.93
  Log likelihood ratio..: 4.771979
  P-value...............: 0.977

5.Location IDs included.: FLFlagler, FLPutnam
  Coordinates / radius..: (29.525009 N, 81.223269 W) / 48.68 km
  Time frame............: 2006/1/1 to 2006/12/31
  Population............: 122398
  Number of cases.......: 3
  Expected cases........: 0.26
  Annual cases / 100000.: 1.9
  Observed / expected...: 11.66
  Relative risk.........: 11.73
  Log likelihood ratio..: 4.634038
  P-value...............: 0.992

NOTE: The sequential Monte Carlo procedure was used to terminate
      the calculations after 259 replications.
```

SaTScan with Covariate Adjustment for Median Income

Program run on: Thu Nov 10 20:40:42 2011

Purely Spatial analysis
scanning for clusters with high rates
using the Discrete Poisson model.

SUMMARY OF DATA

```
Study period..................: 1997/1/1 to 2007/12/31
Number of locations...........: 67
Total population..............: 27
Total number of cases.........: 292
Annual cases / 100000.........: 100003.7
```

MOST LIKELY CLUSTER

1.Location IDs included.: FLBroward, FLMiamiDade
  Coordinates / radius..: (26.138850 N, 80.220032 W) / 40.45 km
  Population.....: 2
  Number of cases.....: 66
  Expected cases.....: 27.11
  Annual cases / 100000.: 243417.9
  Observed / expected...: 2.43
  Relative risk.....: 2.85
  Log likelihood ratio..: 22.831744
  P-value.....: 0.0000000060

SECONDARY CLUSTERS

2.Location IDs included.: FLHernando, FLPasco, FLCitrus,
                          FLSumter, FLHillsborough, FLPinellas,
                          FLLake, FLMarion, FLPolk, FLLevy,
                          FLOrange, FLOsceola
  Coordinates / radius..: (28.504911 N, 82.495409 W) / 112.62 km
  Population.....: 7
  Number of cases.....: 104
  Expected cases.....: 71.95
  Annual cases / 100000.: 144554.1
  Observed / expected...: 1.45
  Relative risk.....: 1.69
  Log likelihood ratio..: 8.723174
  P-value.....: 0.0047

SaTScan v9.1.1

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SaTScan with Covariate Adjustment for Population over Age 65
Program run on: Wed Nov 09 21:41:52 2011

Purely Spatial analysis
scanning for clusters with high rates
using the Discrete Poisson model.

_____

SUMMARY OF DATA

Study period.....: 1990/1/1 to 2007/12/31
Number of locations.....: 67
Total population.....: 25

```
Total number of cases.....: 457
Annual cases / 100000.....: 99998.9
```

```
MOST LIKELY CLUSTER

1.Location IDs included.: FLOrange, FLHernando, FLSeminole,
                          FLLake, FLSumter, FLOsceola, FLPasco,
                          FLBrevard, FLCitrus, FLPolk,
                          FLVolusia, FLHillsborough, FLMarion
  Coordinates / radius..: (28.541206 N, 28.541206 E) / 90.58 km
  Population.....: 6
  Number of cases.....: 175
  Expected cases.....: 105.97
  Annual cases / 100000.: 165138.5
  Observed / expected...: 1.65
  Relative risk.....: 2.06
  Log likelihood ratio..: 26.036785
  P-value.....: 0.00000000021
```

SaTScan with Covariate Adjustment for Population Density

```
Program run on: Fri Nov 11 10:05:16 2011
Purely Spatial analysis
scanning for clusters with high rates
using the Discrete Poisson model.
```

```
SUMMARY OF DATA

Study period.....: 1990/1/1 to 2007/12/31
Number of locations.....: 67
Total population.....: 25
Total number of cases.....: 457
Annual cases / 100000.....: 100001.5
```

```
MOST LIKELY CLUSTER

1.Location IDs included.: FLSaintLucie, FLMartin, FLIndianRiver,
                          FLOkeechobee, FLPalmBeach, FLGlades,
                          FLBrevard, FLHighlands, FLHendry,
                          FLBroward, FLOsceola, FLHardee,
                          FLDesoto, FLPolk, FLOrange, FLLee,
                          FLMiamiDade, FLSeminole, FLCharlotte,
                          FLCollier, FLVolusia, FLSarasota,
```

```
                          FLLake, FLHillsborough
  Coordinates / radius..: (27.359153 N, 80.343490 W) / 214.93 km
  Population.....: 13
  Number of cases.....: 332
  Expected cases.....: 225.00
  Annual cases / 100000.: 147559.9
  Observed / expected...: 1.48
  Relative risk.....: 2.74
  Log likelihood ratio..: 51.859596
  P-value.....: < 0.000000000000000010

SECONDARY CLUSTERS

2.Location IDs included.: FLPasco
  Coordinates / radius..: (28.269642 N, 82.542030 W) / 0 km
  Population.....: 0.5
  Number of cases.....: 19
  Expected cases.....: 9.51
  Annual cases / 100000.: 199767.1
  Observed / expected...: 2.00
  Relative risk.....: 2.04
  Log likelihood ratio..: 3.759915
  P-value.....: 0.436
```