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Examining Geographic and Temporal Variations of AIDS Mortality: Evidence of Racial Disparities

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Background: There is little literature on spatiotemporal trends of AIDS mortality among different race and gender groups. The purpose of the present study is to describe AIDS mortality geographically and temporally, and to determine if detected trends vary by race and gender.

Methods: The Spatial Scan Statistic was employed to examine the geographic excess of AIDS mortality by race and gender in 24 Maryland jurisdictions between 1987 and 2003. Spatial analysis was conducted to identify clusters of excess mortality. The temporal scan statistic was used to explore time trends of AIDS mortality. Prospective space–time analysis was also conducted to verify if detected clusters persisted into the present.

Results: Among 10,887 AIDS deaths, 77.5% occurred in African Americans. Geographic excesses of AIDS mortality were detected in Baltimore city, and Howard, Montgomery, Anne Arundel, Prince Georges and Baltimore counties. Over the study period, AIDS mortality peaked in 1995 and then sharply dropped until 1998, when it stabilized. However, the AIDS mortality of African-American women started oscillating upward in 1998.

Conclusion: This study quantitatively described geographic and temporal variations of AIDS mortality in Maryland by gender and racial groups. The results may inform development of programs to address HIV/AIDS while considering the groups most affected differentially by geographic area.

Key words: HIV/AIDS, mortality

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BACKGROUND

More than 65 million people have been infected with HIV worldwide, and >25 million have died of AIDS-associated conditions since the HIV virus was first reported >2 decades ago.1,2 In the United States alone, the HIV/AIDS epidemic continues to increase, with >250,000 cases of AIDS diagnosed and >35,000 new HIV infections reported yearly.3 There is evidence in the literature that HIV/AIDS disproportionately affects minority communities in the United States.1,2,4-6 For instance, >40% of new infections among adults are in young people 15–24 years of age.6 Moreover, AIDS is the leading cause of death for black women aged 25–34 years.4 However, there is relatively little research on geographic and temporal variations among subpopulations on the east coast of the United States, and particularly in the state of Maryland.

An understanding of geographic variation of disease may provide potential explanation regarding possible proximal and distal contributors to not only AIDS mortality but also HIV infection. Knowing the geographic distribution of AIDS mortality can also inform and improve public health practice. The geographic cluster detection methods may be broadly divided into “global clustering tests” and “cluster detection tests.” The literature provides references in applications, experiences and comparisons when employing different geostatistical methods in the past researches.7-10 Tests for global clustering are used for the detection of clusters but do not provide specific locations such as Global Moran’s I test, Tango’s Maximized Excess Events test, Besag-Newell’s R, Cuzick-Edwards’ k-NN, Oden’s Ipop, Swartz’s Entropy test and Whittemore’s test. Global clustering refers to the analysis where initial cases generate other cases with a comparatively higher probability among their closest neighbors or could be where there are a large number of health hazards scattered through the region. Examples could be infectious diseases or gas stations poisoning. This kind of geographic clustering, however, is not suitable for the present study.

Another cluster detection method is “cluster detecting tests,” which can provide estimates of the likely clusters’ geographical location and extent without previous knowledge of either the number or the location of clusters. These include Kulldorff’s Spatial Scan Statistics, Rushton’s Spatial Filtering Technique and Turnbull’s Cluster Evaluation Permutation Procedure.7-4 These kind
of geographic cluster detection methods fulfill the purpose of the present study in that they aid in detecting the locations of clusters. However, it was also desirable to account for the geographic and temporal clustering simultaneously. In this way, we can determine if the clustering has ended in the past or if it persists into the present. The optimal statistical tool for these purposes is Kulldorff’s Spatial Scan Statistics combined with Space–Time Permutation Analysis. Many studies have analyzed the spatiotemporal variations of different diseases according to subgroups in different states.\(^{11-13}\) However, there is relatively little literature studying AIDS in this field. This underscores the importance of clarifying the spatiotemporal disparity in AIDS incidence or mortality in race or gender groups.

Disparities in health status are well documented among subpopulations in the United States such as African Americans, Hispanics and women, and certainly HIV/AIDS incidence/prevalence is not an exception.\(^{14-16}\) Many studies in the literature have demonstrated that the prevalence of HIV/AIDS remains high among ethnic minorities.\(^ {5,14,17}\) A Centers for Disease Control (CDC) Morbidity and Mortality Weekly Report revealed that an estimated 1.2 million persons in the United States were living with HIV infection in 2003.\(^ {14}\) The report also illustrated that among both genders, African Americans represented the largest percentage of HIV/AIDS cases. From the database of the CDC website, Maryland ranked sixth highest in the proportion of African Americans (around 29\%) among the 50 states and District of Columbia in the United States.\(^ {18}\) Furthermore, when rating the states and Washington, D.C., in the United States, the AIDS mortality rate in Maryland is second only to the mortality rate in Washington D.C. This startling statistic was the motivation for the present study.

To quantify the HIV/AIDS mortality burden by race across space and time, this study adopted a statistical approach to characterize the spatiotemporal clusters of AIDS mortality.\(^ {19}\) A “cluster” is detected within a defined geographical area during a specific timeframe when the area has a disproportionate excess in mortality when compared to the neighboring areas under study. By meeting the assumptions of a set of statistical models, the unusual rise of mortality in a specific spatial and temporal window (with adjustments for demographic factors such as age and gender, or other substantiated risk factors) can be characterized by a statistic, i.e., the observed/expected ratio and its level of significance (p value).

The purpose of this research is to: 1) describe the characteristics of AIDS mortality in different age categories, races and genders; 2) identify the spatial variation and temporal trends between two major subpopulations (African Americans and Caucasians) and different genders in Maryland, a state in which African Americans comprise a fairly large proportion of the population; and 3) evaluate if the excess of AIDS mortality persists into the most recent study period.

### METHODS

#### Data Sources

The AIDS mortality data for the 24 jurisdictions (including 23 counties and Baltimore city) of the state of Maryland were collected from CDC Compressed Mortality website (http://wonder.cdc.gov/mortICD9J.html for year 1987–1998 data and http://wonder.cdc.gov/mortICD10J.html for years 1999–2003 data).\(^ {19,21}\) Information on age, gender, race/ethnicity and county of residence at time of death was extracted. African Americans, Caucasian Americans and three other categories of race were chosen. Data were collected from 1987–2003, for a 17-year study period. The year 1987 was the first year that AIDS deaths were reported in Maryland and became available on this website. For the deaths between 1987–1998, *International Classification of Diseases, 9th Revision* (ICD-9) codes (042) were used, and for the deaths after 1998, ICD-10 (B20-B24) codes were used. Population estimates for each of the 24 counties by each gender for every year during the study period were also obtained from the website.\(^ {20,23}\)

#### Data Analysis

This study employed the Spatial Scan Statistic and spatiotemporal permutation analysis developed by Kulldorff and colleagues to detect potential excess AIDS deaths in a specific area or location (also known as clusters).\(^ {19,21}\) County centroids information, which represented the geometric center of each polygonal-shaped county, of latitude and longitude was downloaded from the 2000 U.S. Gazetteer portion of the U.S. Census Bureau (www.census.gov/geo/www/gazetteer/places2k.html). Geographic coordinates for each county were used as a proxy for the location of Maryland counties under study. The test statistic has been adopted previously for public health surveillance such as detecting excesses of brain and breast cancers.\(^ {20,22,24}\) When compared with other statistical methods for cluster detection, this statistic was found to have good power for detecting localized hot-spot type of excess events.\(^ {25,26}\) This test statistic is therefore appropriate for detecting potential pockets of excess HIV/AIDS mortality in the state of Maryland.

The Poisson model was chosen to analyze the AIDS deaths data. When the number of cases/deaths is substantially smaller than that of the population at risk, the data follow the Poisson probability distribution.\(^ {19,27}\) The null hypothesis under the Poisson model provides that the expected death counts in each county are proportional to the population size (or person-years) in that area and are therefore randomly distributed. The alternative hypothesis is that deaths are not randomly distributed and occur in some areas in a manner disproportionate to the size of the population at risk. In the present study, for each location and size of the scanned space and time,
the alternative hypothesis refers to elevated adjusted mortality rates within the space and time windows as compared to areas outside the scan window. The Spatial Scan Statistic factors in uneven geographical population densities and specified covariates, then analyzes the total number of observed AIDS deaths. Once the null hypothesis is rejected, clusters are formed that mean that the detected cases/deaths in this region are significantly different from the rest of the study areas. Calculations were performed using the SaTScan Program (version 7.0, freeware, www.satscan.org). SaTScan ranks the clusters according to likelihood ratio (LR). Most likely cluster means that it has the largest LR in that calculation, followed by secondary clusters according to the order of LR. There were literatures providing the experiences and methodological supports for this statistical instrument that we employed. Under the Poisson assumption, the LR for a specific window is proportional to: 

$$\frac{C - c}{C - n} \cdot \frac{n}{n}$$

Where C is the total number of AIDS deaths, c is the number of observed AIDS deaths within the space–time window, and n is the covariate(s)-adjusted expected number of deaths within the space–time analysis under the null-hypothesis. I(_proba) is an indicator function, whereby I(_proba) is equal to 1 when the timeframe has more deaths than is expected under the null hypothesis, and 0 otherwise. Based on the test statistic’s value of the LR, a p value is then calculated which suggests how well all the variables fit into the model at the same time. When the LR values of observed windows are higher than LR outside the windows based on simulation, SaTScan determines that there is a cluster in which the cases/deaths in this particular region are significantly different from the rest of the study area by rejecting the null hypothesis. Its distribution under the null hypothesis and its corresponding simulated p value are obtained by repeating the same analytic exercise on a large number (in our study, we chose 999) of random replications of the data set generated under the null hypothesis using Monte Carlo simulations.

The scan setting was set at a maximum cluster size of 50% of the study period and 50% of the population at risk. The “50% of population at risk” parameter is recommended by Kulldorff as an optimal value setting that maximizes the accuracy of potential cluster detection. This means that a cluster would comprise, at most, 50% of the population at risk. To further detect whether the clusters might have persisted into the present time, a second scan analysis was performed with prospective space–time permutation statistics. The alpha level was set at 0.05. The potential persistence of temporal clusters across the entire study period (i.e., 17 years) was tested. The SaTScan program saved the output files, including cluster locations, observed/expected ratio for each location, simulated LRs and the significance level, in database (.dbf format) files. The results of analysis were transferred to geographic information systems (GIS) software (EpiInfo, version 3.3.2) for mapping and spatial queries.

**RESULTS**

**Characteristics of Study Subjects**

Our study included 10,887 HIV/AIDS death cases among an average population of 5,057,471 in the 24 counties of Maryland State across the 17-year study period. The characteristics of the study subjects as well as the percentage of cases by age category, by gender and by study period are presented in Table 1. Proportion B (percentage out of row) displays the proportion that number of total subjects of that row was set as denominator. Among the 10,887 AIDS death cases, 77.5% were African Americans, 22.0% were Caucasian Americans and 0.5% were others (including all subjects who do not fall into the previous categories).

| Table 1. Characteristics of AIDS death cases in Maryland State, 1987–2003 |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Age                                             | All (N=10,887)  | African Americans (n=8,435) | Caucasian Americans (n=2,393) | Others † (n=59) |
| No. %                                           | No. %           | B%*                          | No. %                      | B%*                          | No. %                      | B%*                          |
| <20                                             | 129 (1.2%)      | 105 (1.2%)                  | 81.4%                       | 23 (1.0%)                      | 17.8%                       | 1 (1.7%)                      | 0.8%                          |
| 20–54                                           | 9,853 (90.5%)   | 7,680 (91.1%)               | 77.9%                       | 2,119 (88.5%)                  | 21.5%                       | 54 (91.5%)                    | 0.5%                          |
| >54                                             | 905 (8.3%)      | 650 (7.7%)                  | 71.8%                       | 251 (10.5%)                    | 27.7%                       | 4 (6.8%)                      | 0.4%                          |
| Gender                                          |                 |                              |                             |                              |                              |                              |
| Female                                          | 2,514 (23.1%)   | 2,184 (25.9%)               | 86.9%                       | 318 (13.3%)                    | 12 (20.3%)                   | 12 (20.3%)                    | 0.5%                          |
| Male                                            | 8,373 (76.9%)   | 6,251 (74.1%)               | 74.7%                       | 2,075 (86.7%)                  | 24.8%                       | 47 (79.7%)                    | 0.6%                          |
| Study Period                                    |                 |                              |                             |                              |                              |                              |
| 1987–1998 (12 years)                            | 7,919 (72.7%)   | 5,870 (69.6%)               | 74.1%                       | 1,998 (83.5%)                  | 25.2%                       | 51 (86.4%)                    | 0.6%                          |
| 1999–2003 (5 years)                             | 2,968 (27.3%)   | 2,565 (30.4%)               | 86.4%                       | 395 (16.5%)                    | 13.3%                       | 8 (13.6%)                     | 0.3%                          |

Presented by case number (percent); Proportion B*: Percentage out of row; † Others: includes all subjects neither African Americans nor Caucasian Americans.
not fall into these two categories). With regard to the age characteristic, nine out of ten (90.5%) AIDS deaths occurred among people during their young or middle age (in the category of 20–54 years). The proportion of AIDS deaths occurring before age 20 was 1.2%. The proportion of deaths occurring among individuals aged >54 years was around one out of 12 (8.3%). For African Americans, AIDS mortality rates according to age categories, order of proportion B was youth (<20 years, 81.4%), young and middle (20–54 years, 77.9%) and after middle age (254 years, 71.8%). These results were opposite to the trend of Caucasian Americans, in which the order of proportion B was after middle age (27.7%), young and middle age (21.5%), and youth (17.8%). One in four (23.1%) of the total deaths were women, whereas three out of four (76.9%) were men. Comparing the proportion of subjects in each race respectively, deaths among African-American women accounted for one out of four deaths among African Americans (25.9%), whereas deaths among Caucasian-Americans only made up one out of eight Caucasian-Americans (13.3%). Proportion B, according to gender, showed that African-American women had a greater proportion (86.9%) of deaths among women compared with African-American men (74.7%), and the result was also opposite to the outcome for Caucasian Americans. Table 1 also shows the characteristics by different study periods. There were differential trends in race by study period. For example, compared to Caucasians, African Americans had a higher proportion of AIDS deaths after 1998 (African Americans 30.4% higher than Caucasians 16.5%). Proportion B of the study period revealed that the proportion of African Americans increased from 74.1% from an earlier period (1987–1998) to 86.4% (1999–2003). In summary, the characteristics of AIDS mortality among African Americans relative to Caucasian Americans include young age, higher rates among women and increasing rates in recent years.

**Spatial Clustering**

The average crude annual AIDS mortality rate of all subjects was 12.4 per 100,000, whereas the age-adjusted (to 2000 U.S. population) mortality rate was 8.97 per 100,000 (Table 2). The age-adjusted mortality rate of all women subjects was 3.89 per 100,000, and rate of men was 14.11 per 100,000. Annual age-adjusted mortality rates for Caucasian Americans, African Americans and others (neither Caucasian Americans nor African Americans) were 2.73, 27.19 and 1.26 per 100,000. According to the results of analysis by spatial scan statistics, Table 2 lists the location, population, observed cases, expected cases, observed/expected cases and ratio, and p values in all analyses by race and by gender. For example, the most likely cluster of all African Americans (including women and men) was in Baltimore city. The most likely cluster among all Caucasian Americans was located in Howard, Baltimore Montgomery, Anne Arundel, Prince Georges counties, and Baltimore city. For all deaths and for each race group, the result was adjusted by gender.

| Table 2. Summary of study data, mortality rate, clusters and populations of AIDS mortality by Spatial Scan Statistics in Maryland’s 24 administrative divisions, 1987–2003 |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| **Total**       | **Crude Rate* Per E+5** | **Age-Adjusted Rate* Per E+5** | **Location** | **Population** | **Observed** | **Expected** | **O/E*** | **P** |
| All Races       |                  |                  |                |                |              |              |          |      |
| Total           | 5,057,471        | 12.4             | 8.97           | Balto. city    | 210,728       | 9,400         | 442.75    | 0.001 |
| Women           | 2,609,944        | 5.5              | 3.89           | Balto. city    | 108,748       | 1,518         | 102.37    | 0.001 |
| Men             | 2,447,528        | 19.6             | 14.11          |                | 611,882       | 7,696         | 2042.25   | 0.001 |
| African Americans |                 |                  |                |                |              |              |          |      |
| Total           | 1,369,493        | 35.3             | 27.19          | Balto. city    | 57,062        | 5,308         | 342.42    | 0.001 |
| Women           | 726,758          | 17.2             | 12.52          | Balto. city    | 30,282        | 1,433         | 88.29     | 0.001 |
| Men             | 642,735          | 55.8             | 44.88          | Balto. city    | 26,781        | 3,875         | 254.13    | 0.001 |
| Caucasian Americans |             |                  |                |                |              |              |          |      |
| Total           | 3,484,490        | 3.7              | 2.73           |                | 871,122       | 1,936         | 546.75    | 0.001 |
| Women           | 1,777,623        | 1.0              | 0.68           |                | 444,406       | 246           | 72.75     | 0.001 |
| Men             | 1,706,867        | 6.5              | 4.86           |                | 426,717       | 1,690         | 474.00    | 0.001 |
| Others          |                  |                  |                |                |              |              |          |      |
| Total           | 208,138          | 1.7              | 1.26           |                | 52,035        | 53            | 13.75     | 0.001 |
| Women           | 107,643          | 0.7              | 0.48           |                | 17,940        | 11            | 2.00      | 0.001 |
| Men             | 100,495          | 2.7              | 2.14           |                | 25,124        | 42            | 10.75     | 0.001 |

* #: AIDS mortality rate; * Observed/expected; #: Howard, Baltimore city, Baltimore, Montgomery, Anne Arundel, Prince Georges; †: Howard, Baltimore city, Baltimore, Montgomery; Balto. city; Baltimore city.
Temporal Trends

Figure 1 presents time trend of age-adjusted male AIDS mortality rate per 100,000 by race group. African-American men have the highest mortality rate compared with Caucasian-American men and others. Among African-American males, the peak of the mortality rate was in 1995, then there was a gradual drop. However, the decrease stops at the year 1998 and then stabilizes at around 50 per 100,000 deaths per year.

Figure 2 demonstrates the time trend of age-adjusted female AIDS mortality rate per 100,000 by race. African-American women also have the highest mortality rate compared with Caucasian-American women and others. The years 1994, 1995 and 1996 showed the highest AIDS mortality rates among African-American women, then the mortality dropped for the following two years. Unlike the mortality trend of African-American men, however, mortality started increasing again since the year 1998 and continues to oscillate upward.

Prospective Space–Time Permutation Analysis

Figure 3 demonstrates the cluster of African-American AIDS deaths which persisted into the end of the study period (2003). The cluster located at Baltimore County started in 2000, and its observed/expected ratio was 1.3. Figure 4 shows the cluster of Caucasian-American AIDS death cases, which has continued to the present. The cluster is in Baltimore City, and Howard and Anne Arundel counties. It began in 1997, and its observed/expected ratio was 1.26. Figure 5 reveals the cluster of female AIDS death cases lasting into the present. The most likely cluster started in 1999, in east Maryland, including Kent, Queen Annes, Caroline, Talbot, Dorchester, Wicomico, Somerset, Worcester, Calvert and St. Mary’s counties, and its observed/expected ratio was 2.7. The secondary cluster is also presented in Figure 5, though it does not achieve statistical significance, perhaps because the cluster started in 2003, which is the year that our study period ended. Figure 6 displays the prospective cluster of male AIDS death cases. The cluster started in 1999, located in east Maryland, including Kent, Queen Annes, Caroline, Talbot and Dorchester counties, and its observed/expected ratio was 3.54.

DISCUSSION

According to the literature, a large proportion of new HIV/AIDS infections among adults are in young people 15–24 years of age (around 40%). The present study illustrates that AIDS mortality also occurs mainly (91.7%) in young and middle ages (before 54 years old). The proportion of AIDS deaths >54 years in the present study, which is normally the beginning of a significant increase in general morbidity and mortality, was only one out of 12 (8.3%). This result is very different from mortality research on most other diseases such as cancer, for example.

The present study points toward a marked increase
in the AIDS mortality of African-American population in Maryland in the 17-year study period (1987–2003). In our study, African Americans contributed 77.5% of all AIDS deaths, while Caucasian Americans only accounted for approximately 29% of all AIDS deaths. The age-adjusted AIDS mortality of African Americans (27.19 out of 100,000) was >3 times the rate of all AIDS deaths among men and women. The proportion of youth AIDS deaths among African Americans was larger than that among Caucasian Americans. Furthermore, unlike the trends of Caucasian Americans and men, the time trends of African-American women are characterized by mortality rates oscillating upward after the year 1998 (Figure 2). The characteristics of the high AIDS mortality rate, especially among the youth and women in the African-American population, require more attention.

Geographically, Baltimore city, and Howard, Montgomery, Anne Arundel, Prince Georges, and Baltimore counties were the areas with excess AIDS mortality in the study period 1987–2003. Most of the AIDS deaths occurred in these six administrative districts. There should be especially focused strategies to optimize healthcare for people with HIV/AIDS. Prospective space–time permutation analysis, which can detect if the excess AIDS mortality persisted into the most recent study period, revealed that Baltimore County has been the location of a mortality cluster for African Americans since 2000. This means that the clusters of disproportional AIDS mortality among African Americans have been expanded from the original Baltimore city to the peripheral Baltimore County. Compared with the mortality experience of African Americans, the mortality of Caucasian Americans was much less pronounced. Only three districts (Baltimore City, and Howard and Anne Arundel counties) of AIDS mortality clusters persisted into the present from the original six districts (Baltimore City, and Howard, Montgomery, Anne Arundel, Prince Georges and Baltimore counties).

The east side of Maryland, including Kent, Queen Annes, Talbot, Caroline and Dorchester counties, is becoming a new region with excess AIDS mortality since 1999 among both genders. Other counties of eastern Maryland such as Dorchester, Wicomico, Worcester, Somerset, Calvert and St. Mary’s are also in the clusters of AIDS mortality of women in the prospective space–time analysis, though they are not in the prospective cluster for men. Harford and Cecil were secondary clusters in the prospective analysis of women, though they did not reach statistical significance. However, this cluster begins in 2003, which is the end year of our study period; therefore, it may have potentially continued after the study period ended and warrants attention.

Regarding temporal trend (Figures 1 and 2), the year 1995 was the peak of mortality in both male and female gender and among both Caucasian Americans and African Americans. After this year, the mortality rates decreased gradually. The year 1995 was the year in which highly active antiretroviral therapy (HAART) was...
initiated. Apparently, the effect of HAART is remarkable in all races and both genders. However, there was nonetheless a resurgence of increasing mortality since 1998 among African-American women. This may be due to racial disparities in healthcare. A number of studies have reported disparities in the care provided to minority patients. Minority patients have reported more problems getting the HIV/AIDS care they needed and have been less likely to receive medications for treating HIV/AIDS. Recent studies also documented that minorities have a longer-than-average period between their initial diagnosis and receipt of HIV/AIDS care, and once they begin receiving care for HIV/AIDS, they are still less likely to receive HAART than are nonminority patients. Therefore, the medical providers should use strategies in the clinical settings to optimize the possibility that minority patients such as African-American subjects will be offered, prescribed and use antiretroviral medications. Public health practitioners should also educate the community regarding the importance, effectiveness and necessity of HAART to minority populations particularly African Americans. This may help reduce AIDS mortality rates in this population.

A limitation of the present study was that we could not distinguish deaths directly related to AIDS from non-HIV-related deaths from our dataset. This is particularly noteworthy since non-HIV-related causes of death accounted for one-fourth of all deaths in AIDS patients. Another limitation was that there has been an increasing Latino population in the United States, including Maryland. Since some new Latino guest workers did not have legal status, they were not provided health insurance and
not documented by death registries. This might result in an underestimate of the AIDS deaths and mortality rates of the “other” race category in our study. Another limitation was that in 1987, a new category for HIV infection was added to the ICD-9. In 1999, ICD-10 took effect, which might have resulted in additional deaths classified into the HIV/AIDS category; therefore, death rates for 1987–1998 may not be exactly comparable with those computed after 1998.\(^2\) However, we found only small changes between the two systems.

Regarding the advantages of Spatial Scan Statistics employed in the present study comparing with other geostatistic methods, we listed the strengths and cited some proved references as: 1) not requiring the specification of a particular parameter to define the scale of clustering;\(^7,8\) 2) compared with other methods, the Spatial Scan Statistics has higher statistical power;\(^7,25,26\) 3) it is free and easy to implement. Furthermore, SaTScan can examine temporal effects unlike other spatial-only clustering methods. Weaknesses of the spatial scan method lie in the intrinsic nature of the circular scan method of cluster detection. The detected clusters as the results of circular scans may inadvertently include those geographic regions that do not actually have excess health outcomes but were detected due to the fact that they are within the circular shape. Additionally, linear clusters, e.g., clusters around a river or a road, would not be detected with this method. There is some potential for detection bias in that the spatial scan method may not detect bordering jurisdictions with zero cases. To address this weakness, updated Spatial Scan methods, including the irregular- or elliptic-shaped scan methods, have been proposed.\(^3\)

In conclusion, the present study has identified statistically significant areas of excess AIDS mortality in

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**Figure 5. Cluster of female AIDS death cases in Maryland by prospective space–time analysis**

![Map of Maryland showing clusters of female AIDS death cases](image)

**Figure 6. Cluster of male AIDS death cases in Maryland by prospective space–time analysis**

![Map of Maryland showing clusters of male AIDS death cases](image)
Maryland according to race and gender. The characteristics
of high mortality rate, prevalent tendency in younger
group and higher rates among women form part of the
AIDS mortality experience of African Americans. This
article provides a first attempt to visually and quantita-
tively describe the geographic and temporal characteristics
of AIDS mortality in Maryland, thus demonstrating
the utility of spatial scan statistics in characterizing pub-
lic health problems. These findings can serve to inform
medical care allocation and focus public health inter-
vention strategies for AIDS care.

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