Space-time Analysis of Racial Disparities in Prostate Cancer Late-stage Diagnosis across Florida

Pierre Goovaerts (BioMedware, Inc, Ann Arbor, MI, USA) & Hong Xiao (Florida A&M University, Tallahassee, FL, USA)

BioMedware Geospatial Research and Software

Aims

1. Visualize how the county-level proportion of late-stage diagnosis for prostate cancer changed over time (1981-2007) across Florida.
2. Explore the impact of ethnicity (White, Black, Hispanic) on these geographical and temporal trends.
3. Group counties that share similar temporal trends for proportions of late-stage diagnosis and magnitude of racial disparities..

Material and Methods

- Data: Number of cases of prostate cancer and stage at diagnosis recorded yearly from 1981 through 2007 for each county of Florida and three ethnic subgroups (White, Black, Hispanic). Data were downloaded from the Florida Cancer Data System website.
- Methodology:
  1. **Binomial kriging** (Goovaerts, 2009) to filter the noise caused by small number problem from rates of late-stage diagnosis.
  2. **Disparity statistic** (Goovaerts *et al*., 2007) to detect significant absolute (rate difference) and relative (rate ratio) disparities between rates measured for two ethnic groups.
  3. **Spatially weighted aggregation** (Ward's minimum-variance method in SAS on distance-weighted dissimilarity matrix) to group counties that have similar time series of proportions of late-stage diagnosis and racial disparities (White versus Black) while being close geographically.
  4. **Boundary analysis** (Goovaerts, 2008) to detect county boundaries where significant changes in rates of late-stage diagnosis occur.

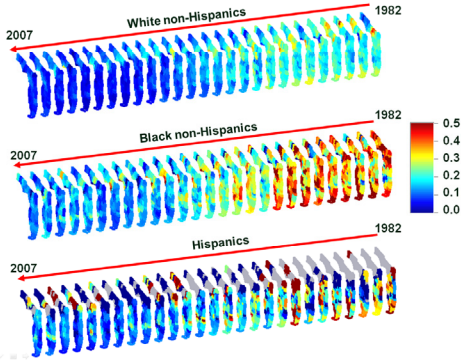

Figure 1: Three-dimensional representation of proportions of late-stage prostate cancer aggregated within 3 year windows and noise-filtered using binomial kriging at the county level for three ethnic groups (cases 65 yr and older). Light gray indicates counties with zero cancer cases for Hispanic.

Space-time changes in % late-stage diagnosis

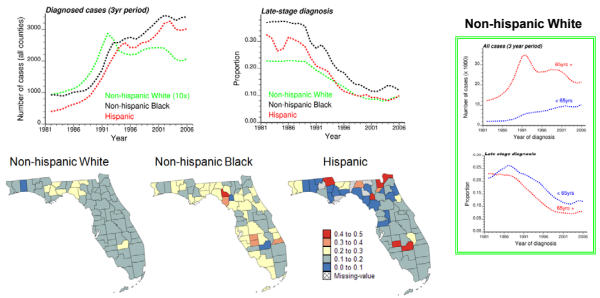

Figure 2: Evolution of the number of diagnosed cases (total + % of late-stage diagnosis) recorded annually over the period 1981-2007 for the entire Florida and three ethnic groups. Results are averaged over a 3yr window to reduce random fluctuations. Bottom maps show for each county the percentage of late-stage diagnosis aggregated over the whole time period. Note: 1) how the shape of time series and geographical location of zones with high percentage of late-stage diagnosis differ among ethnic groups, and 2) the impact of age on results for white males (right column)

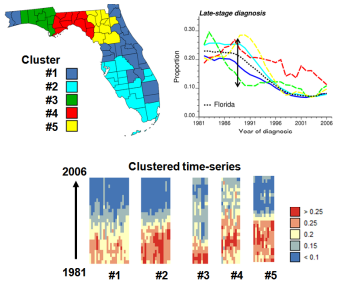

Figure 3: Grouping of counties based on the similarity of their temporal trends in proportions of late-stage diagnosis and their geographical proximity. Some regions experienced a decrease coinciding with the introduction of PSA test, while others (in particular the area around Tallahassee, red color) display a flat trend and higher proportions in the last decade. Individual time series of noise-filtered rates of late-stage diagnosis are displayed as horizontal strings and ordered according to their allocation to one of the five clusters.

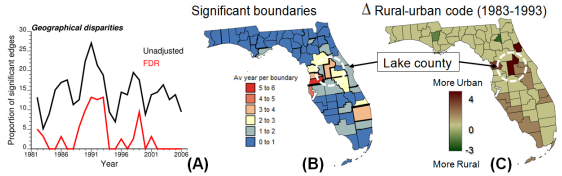

Figure 4: Results of the boundary analysis of white male prostate data displayed in Figure 1: (A) Annual percentage of boundaries that were declared significant before and after adjustment for multiple testing : this percentage peaked in the early 1990s when PSA became widely available, suggesting the existence of geographical disparities in the implementation and/or impact of the new screening procedure, (B) Location of significant boundaries: thickness of black lines is proportional to the number of years when the boundary was found significant, whereas the county color indicates the average number of significant years per boundary for each county (dissimilarity index), and (C) map of change in rural-urban continuum codes for Florida counties over the period 1983-1993.

The counties that differed the most frequently from their neighbours were mainly located in Central Florida (Fig. 4B), an area that underwent large urbanization in the eighties (Fig. 4C). The case of Lake County, located just North of Orlando area, is particularly striking. This county, which takes one of the largest values of the dissimilarity index, is also the county that experienced the **largest increase in urbanization** between 1983 and 1993 according to rural-urban continuum codes; see dark brown polygon in Fig. 4C.

Analysis of racial disparities

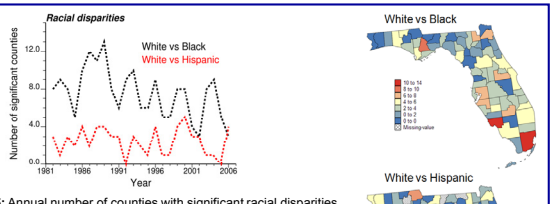

Figure 5: Annual number of counties with significant racial disparities (absolute scale) between the proportions of late-stage diagnosis recorded for two minority groups. For blacks, this number peaked in the early 1990s when PSA became widely available. County-specific results (i.e. number of years with significant tests) are also mapped.

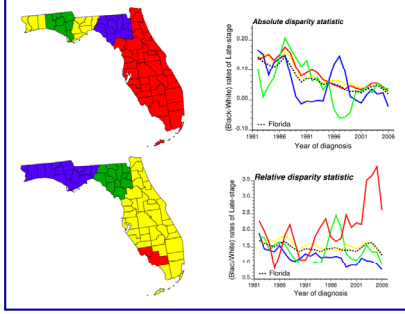

Figure 6: Grouping of counties based on the similarity of their temporal trends in the magnitude of racial disparities (Black vs White). While for most regions the difference between proportions of late-stage diagnosis (absolute disparity) decreased in time, the ratio of rates (relative disparity) remained fairly constant (see also Fig. 2) except in Fort Myers area where it increased with time.

Conclusions

1. All three ethnic groups experienced a 50% decline in the state-average proportion of late-stage diagnosis. This drop started in the early 1990s when PSA became widely available and is the largest for Hispanics.
2. The total number of diagnosed cases kept increasing for Blacks and Hispanics, while it started declining slowly for Whites 65 yrs and older in the early 1990s.
3. Geographical disparities were substantial for all ethnic groups before the mid 1990s. The gap among Florida counties is narrowing with time as the percentage of late-stage diagnosis is decreasing. One outlier is the Big Bend region of Florida where the decline has been the slowest in all Florida for both Whites and Blacks.
4. Current research uses jointpoint regression to model time-series and individual-level data to have access to better covariates.

References:

1. Goovaerts, P., Meliker, J., and G.M. Jacquez. 2007. A comparative analysis of aspatial statistics for detecting racial disparities in cancer mortality rates. *International Journal of Health Geographics*, 6:32.
2. Goovaerts, P. 2008. Accounting for rate instability and spatial patterns in the boundary analysis of cancer mortality maps. *Environmental and Ecological Statistics*, **15**(4), 421-446.
3. Goovaerts, P. 2009. Combining area-based and individual-level data in the geostatistical mapping of late-stage cancer incidence. *Spatial and Spatio-temporal Epidemiology*, **1**, 61-71.

This study was funded by grants #RSGT-10-082-01-CPHPS from the American Cancer Society and grants R43CA150496-01 and R44CA132347-02 from NCI.