Spatial-Temporal Analysis of Cancer Incidence at the Census Tract Level in Massey Comprehensive Cancer Center Catchment Area

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1. Background
Cancer incidence rates for a single time period provide a snapshot of disease burden, but variability—especially in areas with small case counts—can result in wide confidence intervals and obscure true patterns. Additionally, rates reported at county or state levels may mask disparities within smaller geographic units.

2. Goals
Identifying fine-scale trends is critical for addressing cancer disparities and guiding targeted interventions.

3. Solutions and Methods
Virginia Cancer Registry data were analyzed to calculate five-year average cancer incidence rates at the census tract level for 2010-2022. Census tract boundary changes were addressed using the Integrated Public Use Microdata Series National Historical Geographic Information System crosswalk population data adjusted to 2010 census tract shapefiles for 2020's population. To protect patient confidentiality and ensure reliability, tracts with fewer than 16 cases per five-year period were suppressed. Spatial-temporal trends for cancer incidence across the catchment area were visualized using ArcGIS Pro's Space Time Cube and Emerging Hot Spot Analysis tools, enabling identification of persistent and emerging hot spots.

4. Outcomes
Several tracts emerged as persistent hot spots or intensifying hot spots, highlighting communities that suffered from high cancer incidence burden over time. For example, Richmond City's overall cancer incidence rate was 447 (±155) per 100,000 population with a range of 180-833 across 66 census tracts, exposing deep health inequities within close geographic proximity. Community A (the name of the community is suppressed due to privacy) demonstrated a consistent decline from 580 per 100,000 in 2010 to 340 per 100,000 in 2022, while community B maintained persistently high rates (700-900 per 100,000) throughout the same period. Conversely, community C exhibited an intensifying trend, increasing from 400 per 100,000 in 2010 to 600 per 100,000 in 2022. These patterns underscore the urgent need for neighborhood-focused interventions and resource allocation to address these pronounced inequities.

5. Lessons Learned and Future Directions
This spatial-temporal framework offers critical insights for identifying priority populations and developing targeted interventions for cancer prevention, early detection, and resource allocation. By integrating fine-scale geographic data with advanced spatial analytics, the approach strengthens precision public health efforts and can be extended to other cancer outcomes to guide equitable intervention planning across the catchment area.

Figure: Raw Cancer Incidence Rates for Richmond, Virginia at the Census Tract Level

Cancer Incidence Rates
- <= 325
- 326 - 448
- 449 - 568
- 569 - 720
- >= 721

1) The map displays raw cancer incidence rates for Richmond City, Virginia, at the census tract level. (Census tract boundaries are omitted to protect privacy.)
2) Incidence rates are shown for the period 2010 to 2022, arranged from bottom to top on the map.
3) The arrows points to the 3 locations: community A (top right), community B (top left), and community C (bottom).