Identifying geographic disparities in breast cancer mortality in California

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ABSTRACT

Breast cancer is the most common cancer among female Americans and second leading cause of cancer-related deaths. However, population-level routine screening can detect breast cancer at an early stage, reducing the mortality burden. In California, breast cancer mortality shows spatial disparities since many factors that contribute to cancer screening vary by geographical region. Many studies have demonstrated that race and socioeconomic status (SES) influence cancer mortality, but few studies focused on spatial effects. This research aims to identify spatial dependency of breast cancer mortality in California and explore local patterns of relationships between the mortality and socio-demographic factors. We used Moran's I and geographic weighted regression (GWR) applied to mortality rates from the California cancer registry, aggregated at the medical study service area (MSSA) between 2010-2013. From American Community Survey (ACS) 5-year estimates (2009-2013) for the same years and spatial resolution, we created racial topology and SES variables using principal components analysis. A priori variable selection was based on direct acyclic graphing (DAG) methods. We found that age-adjusted breast cancer mortality is significantly correlated in adjacent areas, and some hot spots were detected. Due to this spatial autocorrelation, GWR outperformed linear regression models, with some exceptions in rural areas. Coefficients of racial compsotion and SES variables differed by region, implying that these risk factors are spatially various. Geography is an important variable to consider when studying cancer burden. Our results can help policymakers consider local variation in breast cancer mortality and assoicated socio-demographic risk factors.

BACKGROUND

Breast cancer is the most common cancer among female Americans and second leading cause of cancer-related deaths. However, population-level routine screening can detect breast cancer at an early stage, reducing the mortality burden. In California, breast cancer mortality shows spatial disparities since many factors that contribute to cancer screening vary by geographical region.

Many studies have shown that people with lower SES have higher cancer mortality than those with higher SES, regardless of demographic factors like race/ethnicity[1]. At the same time, ethnic disparities in the cancer mortality are often attributed to obstacles to receiving health care services. The delivery of timely multidisciplinary cancer care is critical to maximize a patient's chances of cure. Unfortunately, minority and socioeconomically disadvantaged cancer patients often experience treatment delays or deviations from standard treatments that directly lead to decreased survival. However, the "landscape" of racial and social cancer disparities is complex,

and the vast majority of research investigating it, even at the small area-level, does not account for the impact of geography, i.e., the adjacency of regions. Geography itself is a set of complex variables that co-vary with other contextual features. Geography has the potential to independently moderate the effect of individual-level factors on cancer occurrence or survival. Conventional aspatial statistical methods widely used in cancer prevention and control research that examine geographic disparities which do not account for local spatial variation are criticized for their inability to estimate the influence of neighborhood effects on outcome[2]. Therefore, this research aims to identify spatial dependency of breast cancer mortality in California and explore local patterns of relationships between the mortality and socio-demographic factors.

DATA & METHODS

We used Moran's I and geographic weighted regression (GWR) applied to mortality rates from the California cancer registry, aggregated at the medical study service area (MSSA) between 2010-2013. From American Community Survey (ACS) 5-year estimates (2009-2013) for the same years and spatial resolution, we created racial topology and SES variables using principal components analysis. A priori variable selection was based on direct acyclic graphing (DAG) methods: race composition, affluence score, population density and walkability score. Moran's I is a measurement of spatial autocorrelation, and its local index (LISA) detect spatial clusters and outliers. As Pearson correlation coefficient, we acknowledge the existence of spatial dependency when the absolute number of the index is over 0.3. On the other hand, GWR is a model that estimates a local regression for each region in a specific boundary, which is determined by spatial adjacency. It generates spatially different coefficients that indicate relationships between variables are not uniform in the entire study area. It is beneficial to navigate how the impacts of racial and socioeconomic factors on breast cancer mortality are spatially different.

RESULTS

We found that age-adjusted breast cancer mortality is significantly correlated in adjacent areas (0.358), and some hot spots were detected in San Diego, Monterey, and Almeda. Due to this spatial autocorrelation, GWR outperformed linear regression models, with some exceptions in rural areas. It can explain 30% of geographic disparities in breast cancer mortality while a linear model (OLS) has a lower value of adjust R^2 (0.05). However, the GWR model illustrates that the breast cancer mortality is closely related to racial and SES factors in the urban areas. Especially in LA metropolitan area and San Fransico metropolitan area, the model fits very well (over 50%), but they also have different patterns regarding the relationships between variables. Overall in California, the component of the Hispanic population has negative impacts (-0.16) on breast cancer mortality, but 30% MSSAs (159 out of 542) show the positive correlations. Also, although most regions are negatively related to breast cancer mortality, there are some exceptional areas. The detected outliers can be examined by further research.

CONCLUSION

Geography is an important variable to consider when studying cancer burden. Our results can help policymakers consider local variation in breast cancer mortality and assoicated socio-demographic risk factors.

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