Spatial methods and applications for cancer epidemiology

Gains in life expectancy during the 20th and 21st centuries have been experienced worldwide (1). Given that the risk of cancer increases with age, this increasing life expectancy has contributed, at least in part, to cancer becoming a major burden of disease globally (2,3). This burden of cancer, measured by incidence, mortality and survival, has been shown to vary dramatically depending on where people live, both between and within countries (2-8).

Understanding the extent and characteristics of this geographical variation has relevance for planning diagnostic, treatment and support services to meet the needs of people living in geographical areas experiencing the greatest inequality. In addition, it has implications for informing the aetiology of different types of cancers, both through ecological analyses and also by providing motivation for further research efforts aimed at better understanding the reasons behind the observed geographical distributions for specific cancer types.

The acceptance and integration of modern geospatial information systems enables routinely collected administrative data to contain more detailed information about geographical location. With that comes the unique methodological challenges of generating robust and stable estimates when using point-location data or the typically low case numbers within specific small geographical areas. In addition, there are important confidentiality and privacy requirements that need to be satisfied before data custodians can release the data for analysis. To ensure these criteria are met, a range of complex statistical methods and innovative visualisations have been developed over time.

The purpose of this Special Series of the journal is to provide some insight into the range of statistical methods and visualisation methods available, and how they are being applied in practice to uncover new insights about the geographical patterns in cancer burden. Papers were eligible for inclusion if they reviewed current knowledge about geographical variations in a cancer-related outcome, provided new data that quantified the extent and patterns of geographical patterns in a cancer-related outcome, or they described novel statistical, geospatial or visualisation techniques that can be used to examine geographical patterns in cancer-related outcomes.

Three of the included manuscripts in this Special Series involve reviews of published studies or existing methods, including a systematic review that identified substantial geographical variation in the type of surgery received for women diagnosed with invasive breast cancer (9), an analytical review of visualisation techniques currently used to communicate statistics (10), and a review of statistical methods used for spatial survival analyses (11). The latter review included a case study of geographical variation in survival for men diagnosed with prostate cancer in Louisiana, USA (11).

The remaining six studies demonstrate a variety of analytical methods for quantifying geographical variation in stomach and liver cancer (6), late stage cervical cancer (7), "screenable" cancers of female breast, colorectal, prostate and cervical cancers (8), melanoma (5), lung and oesophageal cancer (12) and lung cancer (13). While the majority of these studies (6,7,11,12) were based in the United States, Australian (5) and Spanish (13) cohorts gave this collection more of an international perspective.

Consistent with the review of statistical models for spatial survival differences, (11) five of the six analytical papers in this study utilized the Bayesian framework (5-7,12,13), with the other study (8) using a combination of logistic regression and GeoDa software. A clear advantage of these Bayesian models is the ease and transparency of including spatial parameters.

The importance of this rapidly developing field of research is underpinned by the implications of these study results, including identifying geographical regions with higher cancer risk (5-8), improving the understanding of ecological cancer risk factors (5,6) and informing and motivating further efforts to reduce geographical disparities in cancer care (9).

There have been many developments over the last decade, including increasing accuracy and availability of geographical data, and greater recognition by policy and other decision makers of the unique insights gained through a spatial perspective of the burden of cancer. Combined, these mean that there will continue to be a need for further progress in at least three areas. First, the continued development of innovative statistical methodology; second, the ability to apply those methods in real-world situations, and third, probably most importantly, the ability to communicate these results in a way that assists end users to make informed decisions. Ultimately, these efforts should be motivated and designed so that the current widespread geographical inequalities in the burden of cancer is reduced for future generations.

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