Spatial patterns of head and neck cancers in British Columbia

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Abstract

In 2013, 4150 people were diagnosed and 1540 died as a result of head and neck cancers in Canada, figures that are projected to continue rising. Research has shown that cancer risks and outcomes are not homogenous across society, rather, that they are highly dependent on individual biological risk factors, access to treatment centres, and socioeconomic status. However, the spatial variations in incidence, mortality, and the links to socioeconomic status are not fully understood for many cancer types. In this paper, the authors present a novel method for identifying spatial-temporal concentrations of head and neck cancers in British Columbia. Patient data were acquired from the British Columbia Cancer Registry, representing the population of patients who were diagnosed and/or died from head and neck cancers from 1981 to 2010, inclusive. A combination of kernel density estimation and the spatial scan statistic were used to examine how concentrations of incidence and mortality have shifted both spatially and with respect to socioeconomic deprivation. A process of 'suburbanisation' of head and neck cancers was observed, and both incidence and mortality counts were found to significantly differ by neighbourhood deprivation score. This research is being conducted in collaboration with the British Columbia Cancer Agency to inform policymaking and cancer control programmes with the ultimate objective of improving screening, treatment, and palliation.

Background and Relevance

Cancer represents a broad category of chronic disease responsible for 7.6 million deaths worldwide in 2005 (World Health Organization, 2006). That same year, it caused 69 500 in Canada; a number that has grown to 75 500 in 2013 (Canadian Cancer Society's Advisory Committee on Cancer Statistics, 2005, 2013). As the risk of developing cancer increases with age, rises in life expectancy and an aging baby boomer population will further contribute to the growing number of diagnoses, deaths, and prevalence of cancers in Canada. As such, health policy requires detailed knowledge of the population patterns of cancer incidence and mortality in order to proactively address this growing burden.

Previous research has shown that many factors are related to cancer incidence and mortality. Widely known covariates include biological sex, ethnicity, marital status, and income (Baker, Denniston, Smith, & West, 2005; Goodwin et al., 1986; Guidry, Torrence, & Herbelin, 2005; Kravdal, 2001; Mor et al., 1988). Additionally, several studies have identified the role of access to treatment, finding that travel distance to treatment is positively correlated with choice of treatment and subsequently, survival (Celaya, Rees, Gibson, Riddle, & Greenberg, 2006; Nattinger, Kneusel, Hoffmann, & Gilligan, 2001; Schroen, Brenin, Kelly, Knaus, & Slingluff, 2005; Stafford, Szczys, Becker, Anderson, & Bushfield, 1998).

Because cancer risk, incidence, prevalence, mortality, and survival have been shown to vary geographically, Geographic Information Systems (GIS) are uniquely suited tools for analysing these patterns (Brewer, 2006; Jacquez, 2004; McLafferty, 2002; Pickle, Szczur, Lewis, & Stinchcomb, 2006; Rushton, Peleg, Banerjee, Smith, & West, 2004). For example, GIS have been used to demonstrate how cancer rates cluster in space-time (Alexander et al., 1998; Little, 1999; McNally, Alexander, & Birch, 2002; McNally et al., 2003; Mosavi et al., 2007; Steliarova-Foucher et al., 2004). Beyond their abilities to manage, display, and synthesise spatial data, GIS are capable of revealing relationships between cancer cases, clusters, and other spatial phenomena; for example, many studies use GIS to examine the spatial relationship between cancer incidence and environmental risks (Brody et al., 2007; McEntee & Ogneva-Himmelberger, 2008; Polstrup & Hansen, 2004).

While previous research has shown that socioeconomic status is related to cancer survival (Boyd, Zhang-Solomons, Groome, & Mackillop, 1999; Mackillop, Zhang-Salomons, Groome, Paszat, & Holowaty, 1997; Vågerö & Persson, 1987), the ways in which these inequities are manifest in geographical patterns of incidence and survival are not yet thoroughly understood. This research uses a spatial-temporal clustering method to investigate the relationship between socioeconomic deprivation and incidence/mortality for head and neck cancers in British Columbia. To measure deprivation, we use the Vancouver Area Neighbourhood Index (VANDIX), a compound weighted index derived from seven census variables and designed in consultation with public health officers to be specific to health outcomes.

Data and Methods

Oral cancer data were acquired from the British Columbia Cancer Registry in April 2013, comprising two datasets representing the population of new diagnoses (incidence, N=11 459) and deaths (mortality, N=6 798) for British Columbia from 1981-2010, inclusive. The following fields were obtained for each patient: age, sex, period of diagnosis or death (5-year interval), primary residential postal code at time of diagnosis or death, and the primary tumor site (categorised based on the International Classification of Diseases for Oncology codes, version 9). Incidence and mortality were geocoded by patient residential postal code, with 95.7% and 93.7% success rates, respectively.

Kernel density estimation (KDE) was run at multiple bandwidths to identify areas of high case concentrations for both incidence and mortality datasets. The resulting high-density locations were then segregated and local case concentrations were detected using the spatial scan statistic with a space-time permutation model (circular window with 5-year temporal aggregation, bandwidth withheld to protect patient confidentiality). KDE was then rerun for each resulting location to identify micro-scale regions of interest.

Data from the 2006 Canadian Census were used to calculate socioeconomic deprivation (VANDIX) at the Dissemination Block (DB) level (N= 55 505). The micro-scale regions for incidence and mortality categories were then classified by their median VANDIX score, and compared by age, sex, and tumor site group. Age-adjusted incidence and mortality rates for each VANDIX quintile were calculated for both male and female populations, and the results compared to examine the effect of deprivation of sex-specific outcomes. The results were then examined with head/neck cancer experts at the British Columbia Cancer Agency to contextualise findings within the broader cancer control realm.

Results

Strong concentrations of both incidence and mortality were found in urban areas, with unexpectedly high case concentrations identified in some rural regions of British Columbia. Temporally, incidence for both oral cavity and oropharyngeal tumor sites appeared to migrate from dense urban centres to suburban and rural residential areas. The average VANDIX deprivation score for census areas was significantly higher in areas with greater density of incidence and mortality than the provincial average ($p<0.05$), and significant differences in age, sex, and tumor site were found with respect to deprivation.

While this study used a population-based registry of head and neck cancer incidence and mortality, it was limited by a relatively small patient population. Additionally, deprivation was calculated using data from the 2006 census, limiting the temporality of findings to the latter part of the data period.

Conclusions

This research identified case concentrations of head and neck cancer incidence and mortality in British Columbia, characterised by a migration of the diseases to suburbs, exurbs, and rural areas. Differences in both incidence and mortality are reflected in patients' neighbourhood socioeconomic deprivation, evidence that oral cavity and oropharyngeal cancers disproportionately affect deprived communities. Further research will examine how patterns in human papilloma virus-related head and neck cancers differ between urban, suburban, and rural areas, and whether these also conform to a socioeconomic divide.

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