Spatial and Spatio-temporal Epidemiology 21 (2017) 47–55

Contents lists available at ScienceDirect

Spatial and Spatio-temporal Epidemiology

journal homepage: www.elsevier.com/locate/sste

Original Research

Geography of breast cancer incidence according to age & birth cohorts

David I. Gregorio*, Chandler Ford, Holly Samociuk

Department of Community Medicine and Health Care, University of Connecticut School of Medicine, 263 Farmington Ave., Farmington, CT, 06030-6325 USA

ARTICLE INFO

Article history:
Received 7 June 2016
Revised 24 February 2017
Accepted 16 March 2017
Available online 23 March 2017

Keywords:
Breast cancer
Age effects
Birth cohort effects
Spatial analysis

ABSTRACT

Purpose: Geographic variation in breast cancer incidence across Connecticut was examined according to age and birth cohort –specific groups.
Methods: We assigned each of 60,937 incident breast cancer cases diagnosed in Connecticut, 1986–2009, to one of 828 census tracts around the state. Global and local spatial statistics estimated rate variation across the state according to age and birth cohorts.
Results: We found the global distribution of incidence rates across places to be more heterogeneous for younger women and later birth cohorts. Concurrently, the spatial scan identified more locations with significantly high rates that pertained to larger proportions of at-risk women within these groups. Geographic variation by age groups was more pronounced than by birth cohorts.
Conclusion: Geographic patterns of cancer incidence exhibit differences within and across age and birth cohorts. With the continued insights from descriptive epidemiology, our capacity to effectively limit spatial disparities in cancer will improve.

1. Introduction

Studies to uncover the existence, reasons and implications of geographic variation in breast cancer have grown exponentially in number and sophistication over time. Numerous insights are in hand regarding the disease's etiology, how it may be controlled and whether specific health care practices have had desired impact. The assessment of global, along with local, variation in incidence rates offers insight into disease etiology and how it may be better controlled (Sturgeon, et al., 1985; Kulldorff et al., 1997; McPherson, et al., 2000; Gregorio et al., 2002; Sheehan, et al., 2004). With enhanced recognition of 'the geography of affluence' (Klassen & Smith, 2011), epidemiologists strive to measure the distribution of 'risks' associated with the built environment, physical geography and ecosystems, pesticide use, dietary intake, lifestyle, environmental exposures, fertility and reproductive practices, access to screening, tumor biomarkers, and reporting artifact (Laden, et al., 1997; Wennberg, 1999; Brody, et al., 2004; Han, et al., 2005; Kloog, et al, 2008; Millen, et al., 2009; Mulley, 2009; Blyer & Welch, 2012).

The hallmark of most geographic studies of breast cancer, to date, has been the aggregation, and thereby analysis, of events according to when surveillance occurred (what epidemiologists would characterize as the study of 'period effects', Bray, et al., 2004). For most chronic conditions, the time (e.g., year) of diagnosis, in itself, is not presumed to influence the occurrence of disease, but rather, serves as a surrogate for social, biological, environmental and clinical forces at play *prior to that* point in time. Because period

Abbreviations: CTR, Connecticut Tumor Registry; EXP, Expected cases; ICD-O-3, International Classification of Diseases for Oncology, 3rd Edition; NCI, National Cancer Institute; OBS, Observed cases; P-A-R, Population-at-risk; RR, Relative Risk; SEER, Surveillance, Epidemiology and End Results Program.

* Corresponding author.
E-mail addresses: gregorio@uchc.edu, gregorio@nso.uchc.edu (D.I. Gregorio).

http://dx.doi.org/10.1016/j.sste.2017.03.001
1877-5845/

effects apply in roughly equal measure to all persons at-risk of disease, their study in isolation (i.e., looking exclusively at one period) enables, but does not directly establish, causal explanation about exposures and outcomes.

'Age effects' that measure when in the life course is a disease detected are understood to have specific roles in the onset of many diseases (Verbrugge & Jette, 1994; Christensen, et al., 2009), and breast cancer in particular (McPherson, et al., 2000; Siegel, et al., 2016). Aging of the individual, in itself, increases risk of many diseases (Benz, 2008), such that the majority of breast cancer is found in post-menopausal women (Kamińska, et al., 2015). In addition to direct effects, aging indirectly influences breast cancer risks by virtue of when during a woman's life course she typically experiences sexual maturation, child bearing and parity, breastfeeding, menopause, physical activity, weight gain, smoking, alcohol consumption, exogenous hormone use and routine disease screening (Kelsey, et al., 1993; Hulka, et al., 1994; Lambe, et al., 1996; CGHFBC, 2002; Sun, et al., 2002; Sheehan, et al., 2003; Jackson, et al., 2009; Mathews & Hamilton, 2009; Young, et al., 2009; CGHFBC, 2012; Bagnardi, et al., 2013; ACS, 2015). Similarly, age-related changes in breast density and adiposity, epithelium and gene expression are understood to contribute to the onset, detection and course of the disease (Checka, et al., 2012; Garbe, et al., 2012; Pirone, et al., 2012; van der Waal, et al., 2015).

Geographic studies that explicitly examine, rather than merely adjust for, the spatial distribution of disease by age are warranted. Findings from such investigations may highlight when during the life course (and where by virtue of differing age distributions across communities) clinical interventions might reduce incidence and/or severity of the disease.

'Birth/generational cohort effects' underscore secular trends in time that alter exposure of at-risk populations to pathogens, Unlike period or age effects, analysis of data by birth cohorts may offer further insights into social processes and changes that causes disease incidence to vary with time. Socio-economic forces over the last 70 years are believed to have contributed to changes among women in their ages of menarche and menopause, fertility and breastfeeding rates, tobacco use and levels of obesity, as well as education and wealth attainment, exposures to environment hazards, and health services delivery/utilization (Wyshak & Frisch, 1982; Wright & Schanler, 2001; USOSH, 2001; Fuchs, 2012; IBCERCC, 2013; Martin, et al., 2015; DeNavas-Walt & Proctor, 2015; Ryan & Bauman, 2016). As such, elements of a community's social history may both directly 'cause' cancer, as well as indirectly affect the association of age to disease occurrence. Geographic analyses of disease rate according to birth cohorts irrespective of when cases were diagnosed or the ages of affected women could be informative. To the extent that disease incidence for women born before a point in time differ from those born later, geographic analyses by birth cohorts could further our understanding of how changing social conditions have affected disease patterns over time.

Here, we examine geographic variation in breast cancer incidence across Connecticut over 24 years (1986–2009), according to age- and birth cohort-specific groups. Our purpose is to augment what is known about the geography of when incident breast cancer occurred (period effects), with geographic information specific to disease incidence throughout the life course (age effects) and across life experiences (birth effects). It is our hope that attention to the influences of biology (e.g. age effects) and sociology (e.g. birth effects) will expand opportunities for greater disease control.

2. Method

2.1. Data

Between January 1, 1986 and December 31, 2009, the Connecticut Tumor Registry (CTR), a statewide participant in the NCI-SEER program, recorded 63,699 incident breast cancers (i.e., ICD-O-3 - C50.0) among women 40 years and older (WHO, 2013). The Institutional Review Boards of the University of Connecticut and the Connecticut State Department of Public Health approved our access to, and analysis of, this information.

We were able to readily identify the census tract of residence for 60,937 (95.7%) women at the time they were diagnosed with cancer. Each of these records was assigned to one of 828 census tracts used for the 2010 U.S. Census of the state. We estimated the relevant populations-at-risk (i.e. women 40 years and older) through linear interpolation of the decennial U.S. Censuses for 1990, 2000 and 2010 (Geolytics, 2013), without separate adjustment for changes in vital status (e.g., birth's deaths, migration) migration over time. As such, these annual population-at-risk estimates may include random error but are not likely to be systematically biased, as there were no substantial demographic shifts evident within Connecticut between intercensal counts.

For each census tract, we aggregated cases across 24 years of surveillance and then stratified records in quartiles according to age at diagnosis (40–53, 54–64, 65–75 and 76+ years) and year of birth (1884–1921, 1922–1932, 1933–1945 and 1946–1969) cohorts. Ratios of cases-to-population counts yielded crude, age- and birth cohort-specific breast cancer incidence rates for every census tract within the State. Analysis by census tract has been shown to be an efficient unit of analysis for detecting small geographic variation in health events (Gregorio, et al., 2005). No appreciable differences regarding age, race/ethnicity, tumor grade, stage at diagnosis or survival time was noted when we compared these records to the 2762 cases that lacked sufficient information to assign a census tract location.

2.2. Analysis

Geographic variation in disease rates was evaluated using both global and local spatial statistics. Oden's Ipop (Oden, 1995), a global spatial statistic, provided an overall assessment of whether data were spatially clustered across the surveillance area. The Ipop statistic estimated the extent to which census tracts with comparable incidence rates were co-located, and thus, departed from a distribution of spatial randomness.