Exploring the Association Between Demographics and Cancer:
A Visual Analytics Approach

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ABSTRACT

The authors explore the association between demographics and the most prevalent cancers in the United States by analyzing empirical data from the Centers for Disease Control and Prevention, with indicators like cancer site, cancer incidence rate, relative survival rate, death rate, and demographic and lifestyle factors. Identifying cancer-related factors can contribute to improvements in treatment and management of the disease. They use visual analytics to show behavioral factors and age to be associated with increasing incidence rates. Females are more susceptible to breast and males to prostate cancer. As a preventive measure, national healthcare entities, insurance companies, and the government should consider both gender and age factors and monitor behavioral health measures like drugs and diet, in evaluating cancer treatment/mitigation. Preventive care combined with improved outcomes and reduced costs is necessary. The authors offer implications for all developed countries in identifying key areas to target and manage public health.

KEYWORDS

Analytics, Behavioral Factors, Cancer, Demographics, Lifestyle Factors, Preventive Healthcare, Visual Analytics

1. INTRODUCTION

Cancer is a group of diseases that is characterized by the pervasive growth and spread of abnormal cells (American Cancer Society (ACS), 2017; Mayo Clinic, 2019). If uncontrolled, the spread of cancer can ultimately result in death. Approximately 25% of deaths in the United States (U.S.) are believed to be cancer-related (Centers for Disease Control and Prevention (CDC), 2019). Cancer also impacts the psyche due to subsequent feelings of fear and despair. In the 1950s, the British Empire Cancer Campaign (BECC) showed that education on early symptoms of cancer such as campaigns promoting self-examinations for early signs of cancer promoted fear and panic among the population (Law, 2004; Toon, 2007). Polls in both the U.S. and Europe found that at least half the population fear cancer more than any other disease in the world; and one-third to one-fifth fear it more than even potential catastrophes like violent crime, debt, and the loss of a job (Cancer Research UK, 2010; Cancer Research UK, 2011; Eisinger et al., 1994).

Current cancer statistics in the U.S. show that approximately 14 million people are cancer survivors. It is estimated that by 2022 there will be 18 million cancer survivors (American Cancer Society (ACS), 2017). Each year more than 1.6 million people are newly diagnosed with cancer, and by 2030, this annual number is estimated to rise to about 2.3 million people (American Cancer Society

(ACS), 2017). Four cancer sites (i.e., lung, breast, prostate, and colorectal) account for approximately half of all cases and deaths (Tweed et al., 2018).

It has been over 10 years since the Institute of Medicine (IOM) addressed and brought to focus, the quality of cancer care in the U.S. And still, cancer care continues to present a daunting challenge (Institute of Medicine (IOM), 1999). The increasing demand for cancer care, the complex nature of the disease, the increasing cost of healthcare, and a shrinking of the healthcare labor force, are some contributory factors that aggravate this challenge (Jemal et al., 2005). For instance, the high complexity in cancer care can limit the ability of doctors in formulating and administering treatment plans with the needed speed, quality and precision. As a result, some decisions may end up not being completely evidence-based (Institute of Medicine (IOM), 2008; Institute of Medicine (IOM), 2012). Patients may not receive sufficient explanation of the treatment goals at the commencement of treatment or may not be sufficiently informed about the treatment consequences at the conclusion of treatment phase (Institute of Medicine (IOM), 2011). Finally, some patients may not receive the necessary palliative care for managing cancer symptoms and treatment side effects.

A key factor further complicating the national healthcare situation is the changing demographics in the U.S. Increases in the population aged 65 and older place new demands on the delivery of care (Smith et al., 2009). Cancer disparities are an endemic found throughout healthcare systems in the U.S. and other industrialized nations (Choi et al., 2016). The disparities may be based on socioeconomic/demographic indicators such as income, education, ethnicity/race, age, sex, geographic location, or sexual orientation (Albain et al., 2009; Chang et al., 2014; Chang et al., 2013; Field et al., 2005; Molina et al., 2008). The Healthy People 2020 initiative of the U.S. Department of Health & Human Services marked the elimination of health disparities as one of its overarching goals (People, 2020).

The association of multiple demographic and socioeconomic variables with the risk of cancer innately reflects the complexity of the disease. Since socioeconomic circumstances can change during the course of an individual's life, the influence of these variables is felt through the lifespan of the individual. Since it is not feasible to capture all the changes in socioeconomic circumstances during the course of one's life in a single dimension, these variables take on a multidimensional flavor (Parkin et al., 2011; Tweed et al., 2018), making them even more significant.

Demographics and socioeconomic indicators provide a good target to extend the reach and effectiveness of health improvement activities. Recent changes are evident in the distribution of behavioral risk factors (for example, tobacco use), primary and secondary prevention efforts (for example, screenings), and economic and political forces that drive the social determinants of health (Scottish Public Health Observatory, 2008; Stuckler et al., 2010). Thus, there is a need to update our understanding of the impact that demographics can have on cancer incidence.

In addition to demographics, it is also significant to look at lifestyle and behavioral habits of patients to identify associations that can become potential targets for administering preventive healthcare. In 2017, about 190,400 of the estimated 600,920 cancer deaths in the U.S. were associated with cigarette smoking (American Cancer Society (ACS), 2017). In addition, the World Cancer Research Fund estimates that 20% of all cancers diagnosed in the U.S. have some association with a combination of excess body weight, physical inactivity, excess alcohol consumption, and poor nutrition. This suggests that tobacco use and alcohol consumption can be targeted for preventive efforts. For cancers that are related to infective agents such as *Human Papilloma Virus* [HPV], *Hepatitis B Virus* [HBV], *Hepatitis C Virus* [HCV], *Human Immunodeficiency Virus* [HIV], and *Helicobacter pylori* [*H. pylori*], a hybrid treatment approach incorporating the elements of behavioral changes, vaccination, and treatment of infection, should be deployed.

To date, most of the prior research on the influence of environmental or demographic factors on cancer have a unilateral focus in considering one or two types of cancer. Also, the methods deployed for analyzing the influence of various demographic, social or community factors predominantly involve traditional statistical techniques such as regression (Dickey et al., 2016; Kangmennaang et al., 2016), and Poisson distribution (Keane et al., 2014). Among those that consider visual modeling, studies

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