PROJECTING CANCER INCIDENCE: HOW DO INCIDENCE RATES VARY ACROSS VIRGINIA AND ITS COUNTIES?*

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Abstract
Cancer is a leading cause of death in the U.S. Projecting cancer incidence is critical in understanding future needs with respect to resource allocation and priority setting, as well as planning for health care facilities and workforce.

In this paper, we used the state of Virginia as a case study. The Virginia population projections by age and sex were employed in conjunction with the administrative data from the Virginia Cancer Registry to derive the cancer incidence projections for the state and its counties and independent cities over the decades of 2020, 2030 and 2040.

Results show that new cancer cases would be increasing much faster than the growth of the overall population, due to population aging. In addition, geospatial analysis indicates that while major metro areas will see the largest number of new cases, rural counties will face the highest burden of cancer as measured by incidence per 100,000 population.

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1. Introduction

Cancer is a leading cause of death in Virginia\(^1\). Between 2001 and 2010, more than 340,000 new cancer cases were diagnosed. While steady and significant progress has been made in cancer diagnostic techniques, treatment, and survival, the impact of cancer on the lives of individuals and their families—and on the Commonwealth—is notable.

Nationwide, nearly 590,000 people were estimated to have died from cancer in 2014—or 1,600 per day—making cancer the second leading cause of death (after heart disease) in the U.S.\(^2\) Since cancer is known to be closely associated with age, future cancer incidence depends on both the size of the population as well as its age profile. As Virginia’s population is growing, and is growing older, this project aimed to examine how many people in the Commonwealth may be diagnosed with cancer over the next few decades.

With age playing such a vital role in cancer incidence, using the administrative health data in combination with our population projections by age, provided us the perfect opportunity to demonstrate how demography can contribute to understanding future disease incidence or prevalence. Anticipating the future burden of cancer in Virginia sets the stage for policy development and resource allocation appropriate to cancer’s impact on individuals, families, communities, employers, the Virginia workforce, and an already stressed health care industry scrambling to keep up with demand. Projecting incidence of cancer in Virginia over the next few decades provides one element of the foundation to address these needs.

2. Research Question

Virginia’s population is growing not only bigger, but, more significantly, older. Since age is an established risk factor for cancer, with the vast majority of cancer diagnoses occurring in people over age 55\(^3\), this paper attempts to see how many people may be diagnosed with

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\(^1\) From Cancer in Virginia 2014 release using VDH Division of Health Statistics, based on combined 2008-2012 data. Mortality rates are age-adjusted to the 2000 U.S. standard population.


\(^3\) Age is an established risk factor for cancer. Cancer Facts and Figures 2015, The American Cancer Society.
cancer over the next few decades in Virginia’s 134 localities, accounting for age distribution and geographic variation.

Map1: Median Age, 2010 by Quartiles

- 22.4 - 38.0 years
- 38.1 - 42.0 years
- 42.1 - 44.1 years
- 44.2 - 54.1 years

Map2: Cancer Incidence Rate (per 100,000), 2001-2010 by Quartiles

- 248.3 - 471.5
- 471.6 - 536.8
- 536.9 - 589.8
- 589.9 - 861.8
The projected number of new cancer cases depends on both the size of the population and its age profile. Since the population of Virginia is growing and the baby-boomer generation is aging, and since the vast majority of cancer diagnoses occur in people over age 55, we anticipate the increase of new cancer cases to significantly outpace population growth.

3. Methodology

The projections are developed along the following dimensions:

Geography: Virginia and its 95 counties and 39 independent cities

Time period: Decades of 2011-2020, 2021-2030, and 2031-2040

Cancer Types: 3 most commonly occurring cancers—lung, breast (for females alone), and prostate—as well as the aggregate for all cancer sites.

We combine multiple data sources by collecting administrative records from the Virginia Cancer Registry and using them in conjunction with the Census population counts as well as official state population projections.

Data:
This report draws upon data collected by the Cancer Registry at the Virginia Department of Health from 2001-2010. These are incidence data for each reportable tumor, and are arranged geographically according to the patient’s place of residence at the time of diagnosis. Cancer incidence refers to initial diagnosis or treatment of malignant tumors, they may include multiple primary cancers occurring in one patient.

The input data from the Virginia Cancer Registry include 2001-2010 age-specific incidence rates for lung cancer, female breast cancer, and prostate cancer, as well as for all sites.

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4 Our projections are based on 2001-2010 Virginia Cancer Registry data which consider Bedford County and Bedford city as separate localities, we continue to report the numbers for them separately. As of July 2013, Bedford city reverted to being an incorporated town and lost its independent city status; so projections for Bedford County and Bedford city can be aggregated under a single locality.

5 VCR database includes data collected for all Virginia residents, including those who were diagnosed elsewhere as it receives reports from all bordering states (Kentucky, Maryland, North Carolina, Tennessee, West Virginia, and Washington, D.C) and from select other states, including Florida, Georgia, New York, Pennsylvania, and South Carolina.
(meaning all types), at the state and locality levels. The projected population at risk for 2020, 2030, and 2040 are from the official Virginia Population Projections\(^6\), developed by the Weldon Cooper Center for Public Service (WCC) in 2012.

![Figure 1: CANCER INCIDENCE BY MAJOR TYPES IN VIRGINIA, 2001-2010](image)

**Assumptions:**
We assume that age-specific cancer incidence rates would be constant over time; in other words, the proportion of the population (measured per 100,000) in a given age bracket (say, 60-64) diagnosed with a new cancer in the period of 2001-2010 remains unchanged for the following three decades. This means we did not account for potential future rate changes, which could arise from technological advances in cancer diagnosis, improvements in access to medical services and facilities (such as health insurance, transportation), and increased public awareness about cancer leading to evolution in lifestyles, all of which could benefit cancer prevention, enable better screening or allow earlier diagnoses. While some factors

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\(^6\) http://www.coopercenter.org/demographics/virginia-population-projections
may increase diagnoses, hence raising incidence rates, others, such as prevention, may reduce them — the aggregate effect of these multiple factors on cancer incidence could work in either direction and is difficult to predict, therefore we assume that the age-specific pattern will remain relatively unchanged at least for the near future.

**Estimation:**
The locality-level rates from the Virginia Cancer Registry data were applied to the projected population at risk for each decade in order to compute the expected number of cancer cases in each locality. The main elements of our calculations are listed below.

*Given: Census Count Population\textsuperscript{2010}, WCC Projected Population\textsuperscript{2020}, WCC Projected Population\textsuperscript{2030}, WCC Projected Population\textsuperscript{2040}, and VCR Cancer Incidence Rate\textsuperscript{2001-2010}*

We used age-specific data and applied cancer incidence rates to population in each age cohort. Following is an example of calculations for (60-64 year olds):

- **Population Base**

  WCC Estimated Population\textsuperscript{2011,60-64} = Census Count Population\textsuperscript{2010,60-64} + \frac{(WCC Projected Population\textsuperscript{2020,60-64} - Census Count Population\textsuperscript{2010,60-64})}{10}

- **Population at Risk**

  Using the population counts for 2000, 2010 and projections for 2020, 2030 and 2040, we constructed the aggregate population size for each entire decade. We assume the growth in each year is one-tenth of the total growth over the decade, and this uniform distribution is used to estimate the population in the years 2011, 2021 and 2031. For example, the 10 year aggregate population for age group 60-64 over 2011-2020 was calculated as
Population at Risk\textsubscript{2011−2020}_{60−64} = \frac{(\text{WCC Estimated Population}\textsubscript{2011} + \text{WCC Projected Population}\textsubscript{2020})}{2} \times 10

- **Projected Cancer Incidence**

For each age group, projected cancer incidence was derived by multiplying the observed age-specific incidence rate for 2001-2010 from the Virginia Cancer Registry to the projected population at risk for that age group. For instance,

\[
\text{Projected Cancer Incidence}\textsubscript{2011−2020} = \frac{\text{VCR Cancer Incidence Rate}\textsubscript{2001−2010} \times \text{Population at Risk}\textsubscript{2011−2020}}{\text{Population at Risk}\textsubscript{2011−2020}} \times 100,000
\]

We summed all age groups to derive the locality-specific cancer incidence. The sum of the numbers for all the localities yielded the state totals for Virginia.

- **Projected Crude Cancer Incidence Rate**

In addition, crude incidence rates were calculated based on the observed and projected incidence. Following is an example for the decade of 2011-2020, after summing all age groups:

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\text{Projected Crude Cancer Incidence Rate}\textsubscript{2011−2020} = \frac{\sum_{\text{Age Group}=0−4}^{85+} \text{Projected Cancer Incidence}\textsubscript{2011−2020} \times \text{Population at Risk}\textsubscript{2011−2020}}{\sum_{\text{Age Group}=0−4}^{85+} \text{Population at Risk}\textsubscript{2011−2020}} \times 100,000
\]

Crude rates can be used to examine the local burden of cancer. They reflect the number of new cancer cases expected to be diagnosed per 100,000 people in a particular geographic unit. Crude rates for 2001-2010 were constructed in the same way to enable comparison across decades. They are different from the age-adjusted incidence rates.
4. Results

Some of the key findings are:

- In the near future, the projected cancer incidence growth outpaces the population growth, primarily due to an aging population. While the statewide population is projected to increase by about 10% by the endpoint of each decade, the number of new cancer cases over the course of the decades ending in 2020, 2030, and 2040 is expected to increase by 26%, 20%, and 12%, respectively. The difference between the rate of population growth and the rate of increase in cancer incidence illuminates the significant impact of an aging population. The momentum of increase in the cancer burden is projected to slow each decade, especially after 2030, in part due to a much smaller baby-bust cohort, which followed the baby-boom generation.
• The highest projected number of new cancer cases for the current decade of 2011-2020 are in the state’s major metropolitan areas, especially among population centers such as Fairfax County, Virginia Beach, Chesterfield, Henrico, and Prince William.

• On the other hand, the largest percentage increases are projected to take place in the fast-growing localities of Stafford, Loudon, Spotsylvania, Prince William and James City, which top the list for the highest projected change in terms of new cancer cases between the decades of 2001-2010 and 2011-2020.

• The cancer burden, measured by new cancer cases per 100,000 people, is greatest among some of Virginia’s rural counties with older populations. While many rural communities are not expecting much growth in population size, the aging of the community is certain and significant. Where the young tend to move away, and older residents continue to stay, cancer incidence rates are already high and keep rising over time as the population becomes even older. By 2020, Northampton, Lancaster, Northumberland, Middlesex, and Mathews are projected to be counties with the highest cancer incidence rates, above or near 900 cases per 100,000.

5. Policy Relevance

Every day, medical professionals diagnose and treat cancer patients, clinical researchers look for ways to prevent and cure cancer, and policy makers allocate resources for advancement of cancer programs. With the Commonwealth’s population growing and aging, we, as demographers, attempted to see how many people may be diagnosed with cancer over the next few decades.

Further, these findings were invited to be shared with the Virginia General Assembly’s Joint Commission on Healthcare and presented to the University of Virginia’s Cancer Center. Since these are organizations that play an active role in planning and policymaking across the
Commonwealth, the projected cancer incidence numbers will actually help inform decision makers as they prepare to meet the future demands of cancer on the health industry, including patient care, planning for facilities and workforce management, among others.

While projections are inherently uncertain, as the future is largely unknown, the projections at large geographic levels (such as state and region) for combined years (over a decade), and for the near future (such as 2020 and 2030) prove to be highly valuable. The Virginia cancer incidence projections, based on observed trends in both population and cancer rates, provide a lens to look into the future and understand the burden of the disease. These projections not only illuminate the importance of research to prevent, diagnose, and treat
cancer, but also highlight the needs and priorities for resource allocation across the Commonwealth at state and local levels, as we come to terms with the disease over the next several decades.

Using population projections with high-quality administrative records enabled us to generate these projections for cancer incidence across Virginia and its localities. Since the age specific cancer incidence rates collected by the Virginia Department of Health provides a warehouse of very accurate and credible data, we found the opportunity to demonstrate the unique perspective that demography offers to other fields like cancer research. Applying these rates to projected population trends by age-cohorts provided us with new avenues to explore methodological extensions, and also helped demonstrate the interdisciplinary nature of demography and its value-added contribution to the health sector.

In terms of future research, the same methodology could be applied to look at other health issues and diseases that may be impacted by variations in age or geography, provided appropriate administrative data is available.

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NOTE: Locality specific data on Cancer Projections by type are available upon request.