

Cancer epidemiology

D. M. Wood, August 2017

Contents

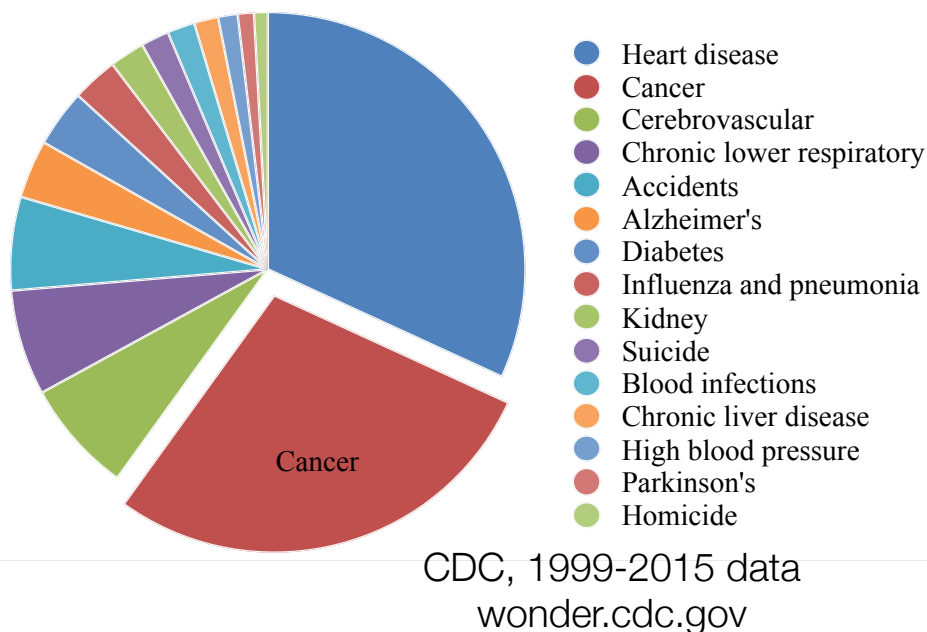
<i>Cancer diagnosis and death rates</i>	1
<i>Causes of cancer</i>	3
<i>Particular cancer types by state</i>	4
<i>Take-away points</i>	5

Many people (me included) do not know important facts about cancer. For example, what fraction of cancers are genetically determined and which are determined by 'environment'? What are the non-genetic causes of cancer? This document provides some background.

Cancer diagnosis and death rates

Cancer remains the second leading cause of death in the US [1]; the principal causes of deaths are shown in Fig. 1.

Figure 1: Leading causes of death [1]



In the US, the National Cancer Institute has maintained

since at least 1973 Surveillance, Epidemiology, and End Results (SEER) databases (available [here](#), [2]) of the probability of developing (that is, being diagnosed with) and dying of a large variety of cancers, broken down by age, ethnicity, location, and a number of other criteria. The software package DevCan [3] can be used to produce tables to display this data. DevCan version 6.7.5 was released in April 2017. Using this and a cohort (a very large group of people of varying ages followed over a defined period of years) labeled 2012-2014 in the databases, we find the curves shown in Fig. 2. If you are male, your

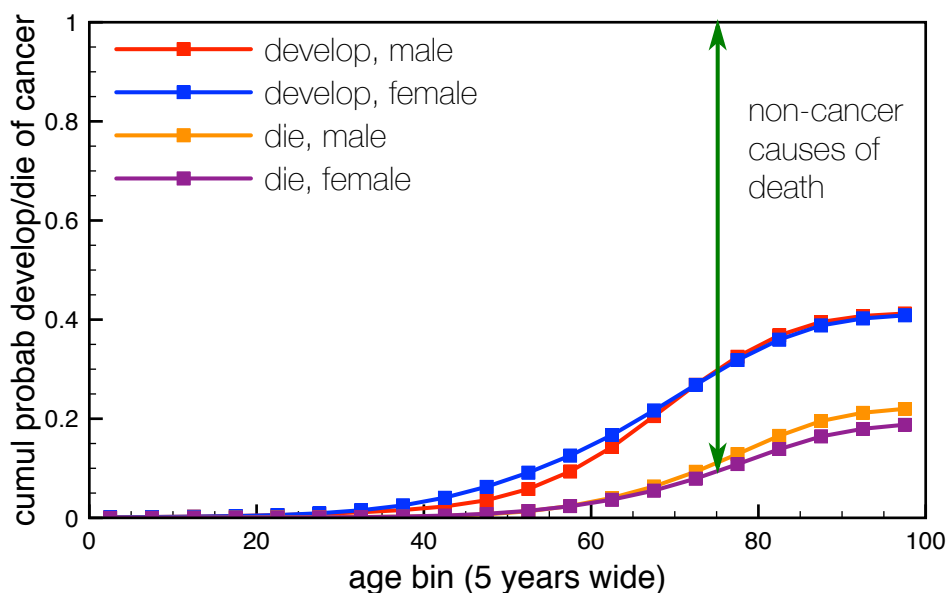


Figure 2: Age-dependence of diagnosis and death rates due to cancer [2]

lifetime chance of developing cancer is about 41.2% and your lifetime chance of dying of cancer is about 22%; for women the numbers are 40.8% and 18.8%.

The Institute for Health Metrics and Evaluation maintains [4] similar databases broken down geographically. The significance of Fig. 3 is that cancer death rates are very non-uniform around the country, generally an indicator of regional lifestyles and socioeconomic status. *Colorado has among the very lowest cancer rates in the U.S.* Explanations for this range from patterns of obesity and exercise [6] to the carcinogenic aspects of oxygen itself (reduced by altitude, naturally) [7], in the case of lung

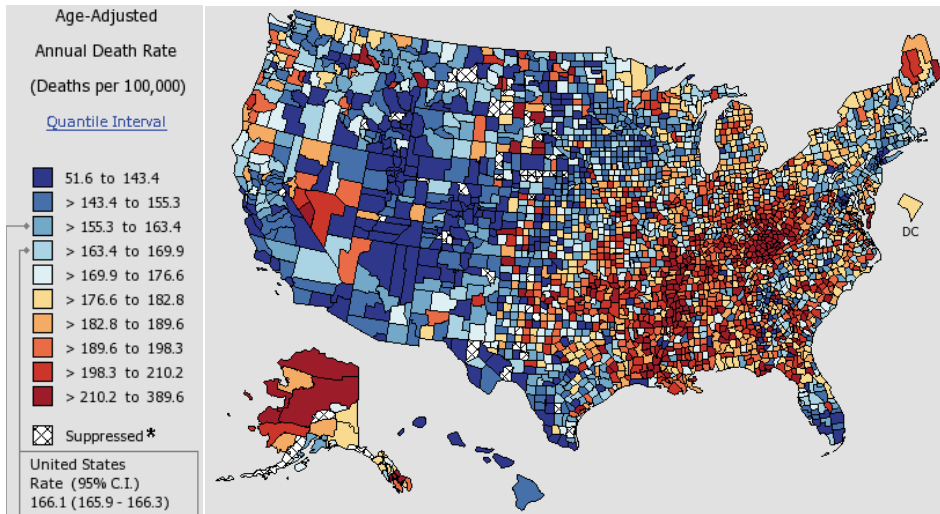


Figure 3: Cancer death rates by counties in US. [5]

cancer.

Understanding this is a job for *cancer epidemiology*. Let's dig further into the issue of the *causes* of cancer.

Causes of cancer

The familiar 'nature vs. nurture' terminology can be modified in cancer epidemiology to 'genetic' vs. 'environmental' causes, where environmental includes diet and other lifestyle-related choices. An extremely well-known 2008 article *Cancer is a preventable disease that requires major lifestyle changes* [8] attempted to answer precisely these questions. This study used cancer rates among identical twins to evaluate the genetic component of cancer risk (i.e., the fraction of cancer cases that is attributable to inheritance). They used a cohort of residents of Utah to disentangle other factors which appeared to account for *environmental* (that is, *non-genetic*) causes of cancer. The results of their data is re-plotted in Fig. 4. We note that (i) environmental factors (lifestyle choices such as diet and tobacco and alcohol use) are *much* more important than either genetic determinants (which account for 5-10% of all cancers) or unspecified ("other") causes in this data. (ii) Exposure to all forms of radiation are sub-

It is perhaps surprising that infections are an important contribution to cancer. In an article published in 2012 [9] at least 20% (in sub-Saharan Africa) of new cancers in 2008 were attributable to known infectious agents such as the viruses carrying Hepatitis B and C, human papillomavirus, and the bacterium *Helicobacter pylori* (stomach cancer).

These numbers hold for an *average* person, not for an employee of a nuclear plant or a nuclear weapon victim.

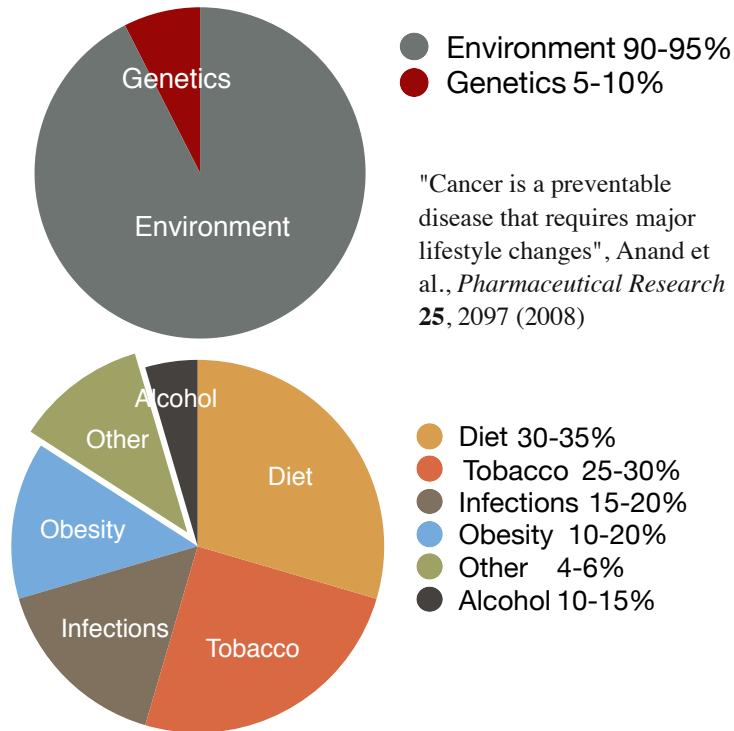


Figure 4: Estimated environmental vs. genetic contributions to cancer risk, top panel; estimated environmental (non-genetic) contributions to cancer risk, lower panel.

summed into the category “Other”, accounting for 4-6% of all environmentally-determined cancers.

As of October 2017 [CDC Morbidity and Mortality Weekly Report, October 3 2017 [10]] it is estimated that about 55% of cancers diagnosed in women and 24% of those diagnosed in men are related to being overweight or obese. This estimate differs from the pie chart above because it is much more recent, but also because diet is entangled with ‘metabolic syndrome’, a set of conditions which include excess body fat, high blood sugar, abnormal cholesterol and/or triglyceride blood levels. 13 particular cancers [11] are specifically associated with being obese or overweight.

Particular cancer types by state

If we select cancers (leukemia, thyroid cancer, or uncommon cancers) which we might suspect would be present near radiation sources, we get the 2014 data shown in

Fig. 5 on the next pages.

Take-away points

- Most cancers (90-95%) can be legitimately regarded as 'lifestyle' diseases (related to diet, tobacco and alcohol use)
- Over the American public, only 4-6% of these are attributable to 'external' causes such as exposure to radiation
- The variability of cancer rates across the US is enormous.
- At a county level, this remains true for leukemia, thyroid cancer, and unusual cancers. [Not shown in graphics:] Jefferson County, Colorado exhibits no unusual cancer death rates in any of these categories.
- Colorado has among the lowest cancer rates in the United States.
- To minimize your risk of cancer [13], pay attention to diet, obesity, tobacco and alcohol use. To minimize your children's risk of lifetime cancer, make sure they are inoculated against diseases which under some circumstances cause cancer (e.g., HPV).

References

- [1] US Centers for Disease Control and Prevention. *CDC WONDER*. URL: <https://wonder.cdc.gov/> (visited on 11/06/2017).
- [2] *SEER Data, 1973-2014*. URL: <https://seer.cancer.gov/data/> (visited on 11/06/2017).
- [3] *Probability of Developing or Dying of Cancer - Surveillance Research Program*. URL: <https://surveillance.cancer.gov/devcan/> (visited on 11/06/2017).
- [4] Institute for Health Metrics and Evaluation. *US County Profiles* | Institute for Health Metrics and Evaluation. URL: <http://www.healthdata.org/us-county-profiles> (visited on 11/06/2017).

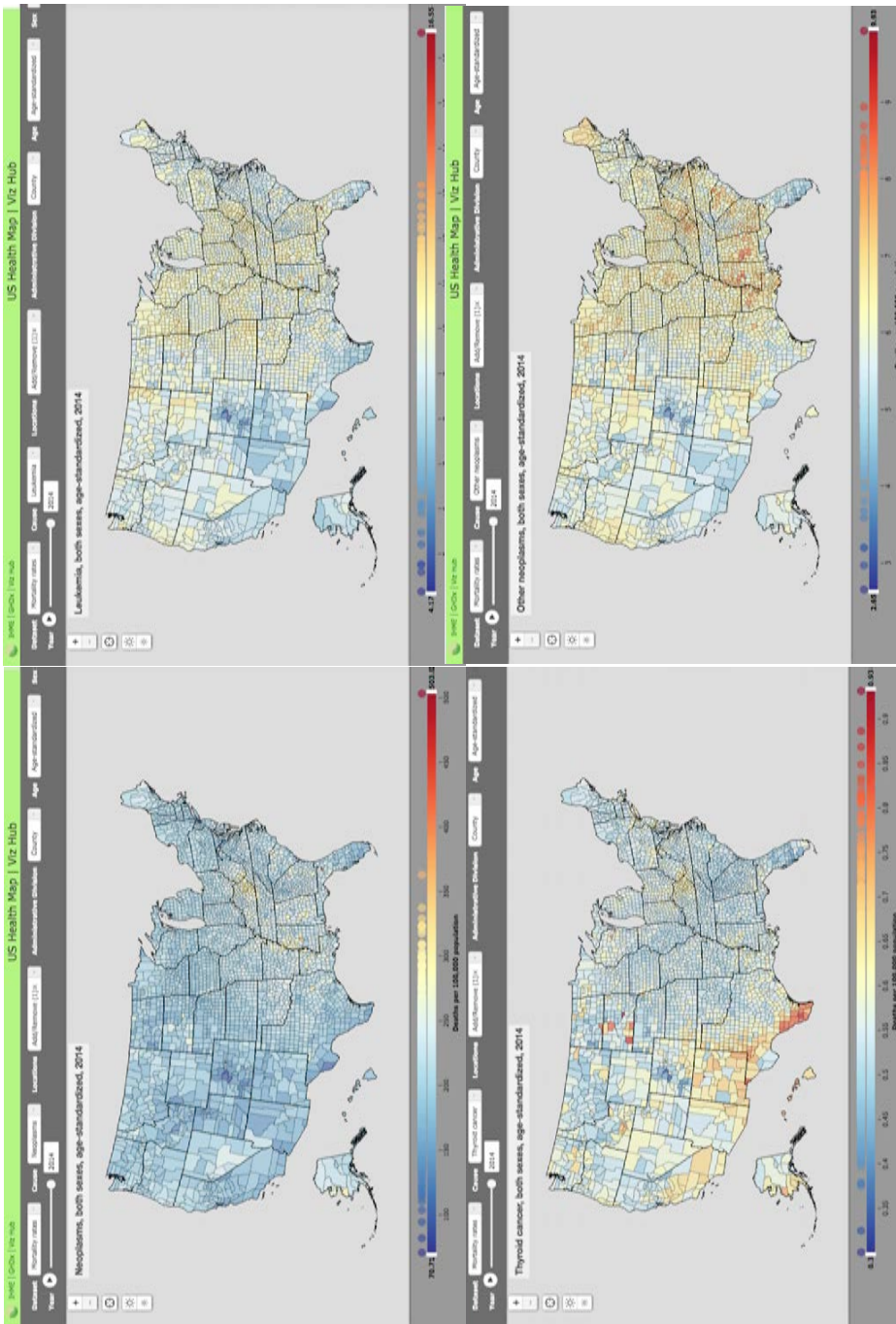


Figure 5: Death rates due to all cancers, leukemia, thyroid, and unusual cancers, by county in US as of 2014. [12]

- [5] Cancer.gov. *Interactive Maps*. URL: <https://statecancerprofiles.cancer.gov/map/map.withimage.php?99&001&001&00&0&02&0&1&10&0#results> (visited on 11/06/2017).
- [6] DataSplashMedia. *Exploring Chronic Disease Data with Visualizations* | Digital Splash Media. 2014. URL: <http://digitalsplashmedia.com/2014/01/exploring-chronic-disease-data-with-visualizations/> (visited on 03/01/2018).
- [7] Kamen P. Simeonov and Daniel S. Himmelstein. "Lung cancer incidence decreases with elevation: evidence for oxygen as an inhaled carcinogen". In: *PeerJ* 3 (2015), e705. ISSN: 2167-8359. DOI: [10.7717/peerj.705](https://doi.org/10.7717/peerj.705). URL: <https://peerj.com/articles/705>.
- [8] Preetha Anand et al. "Cancer is a preventable disease that requires major lifestyle changes". In: *Pharmaceutical Research* 25.9 (2008), pp. 2097–2116. ISSN: 07248741. DOI: [10.1007/s11095-008-9661-9](https://doi.org/10.1007/s11095-008-9661-9).
- [9] Gulnar Azevedo E Silva et al. "The fraction of cancer attributable to ways of life, infections, occupation, and environmental agents in Brazil in 2020". In: *PLoS ONE* 11.2 (2016), pp. 1–13. ISSN: 19326203. DOI: [10.1371/journal.pone.0148761](https://doi.org/10.1371/journal.pone.0148761).
- [10] C. Brooke Steele et al. "Vital Signs: Trends in Incidence of Cancers Associated with Overweight and Obesity — United States, 2005–2014". In: *MMWR. Morbidity and Mortality Weekly Report* 66.39 (2017), pp. 1052–1058. DOI: [10.15585/mmwr.mm6639e1](https://doi.org/10.15585/mmwr.mm6639e1). URL: <http://www.cdc.gov/mmwr/volumes/66/wr/mm6639e1.htm>.
- [11] Centers for Disease Control and Prevention. *13 cancers are associated with overweight and obesity*. 2017. URL: <https://www.cdc.gov/vitalsigns/obesity-cancer/infographic.html#graphic> (visited on 03/01/2018).
- [12] Institute for Health Metrics and Evaluation. *US Health Map* | IHME Viz Hub. URL: <https://vizhub.healthdata.org/subnational/usa> (visited on 11/06/2017).
- [13] American Cancer Society. *Cancer Death Rates Vary Greatly Among US Counties*. URL: <https://www.cancer.org/latest-news/cancer-death-rates-vary-greatly-among-us-counties.html> (visited on 11/06/2017).

Reminders: (i) Just click on a reference in the text to reposition the cursor in the bibliography; (ii) generally by simply clicking on the URL field or the DOI field in

a bibliographic entry will fire up your Web browser and take you to where the original file is available.