

Cancer epidemiology

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November 2023: Slight updates; data correct but somewhat out of date

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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.

Modifications, November 2023: fixed broken links, added some recent data

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. 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 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%.

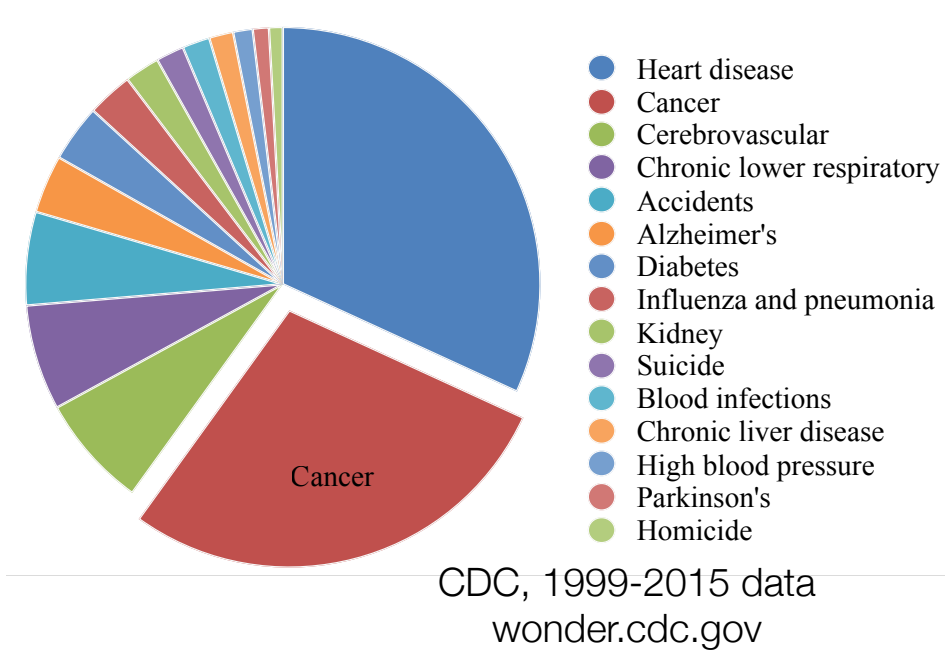


Figure 1: Leading causes of death [1]

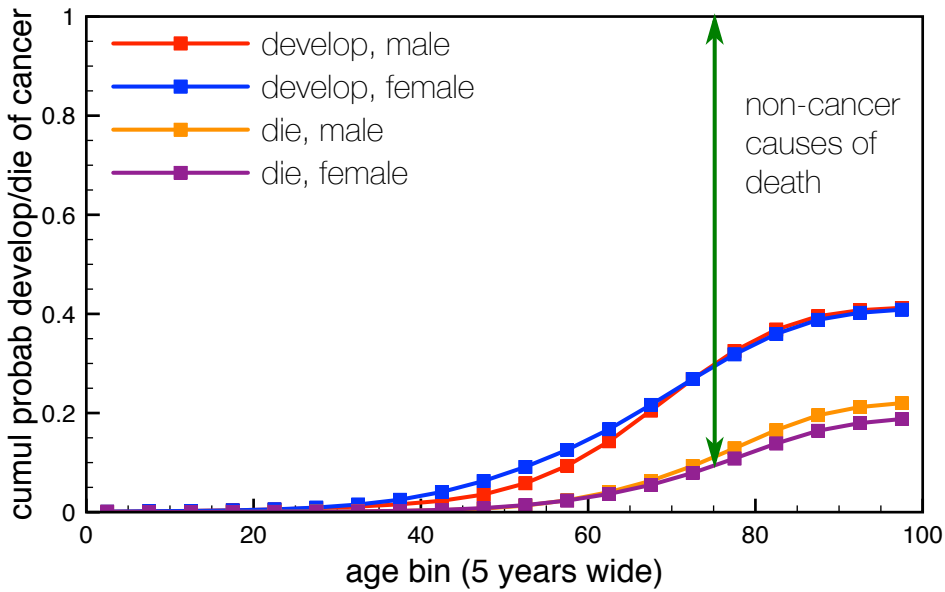


Figure 2: Age-dependence of diagnosis and death rates due to cancer [2]

The Institute for Health Metrics and Evaluation maintains [4] similar databases broken down geographically.

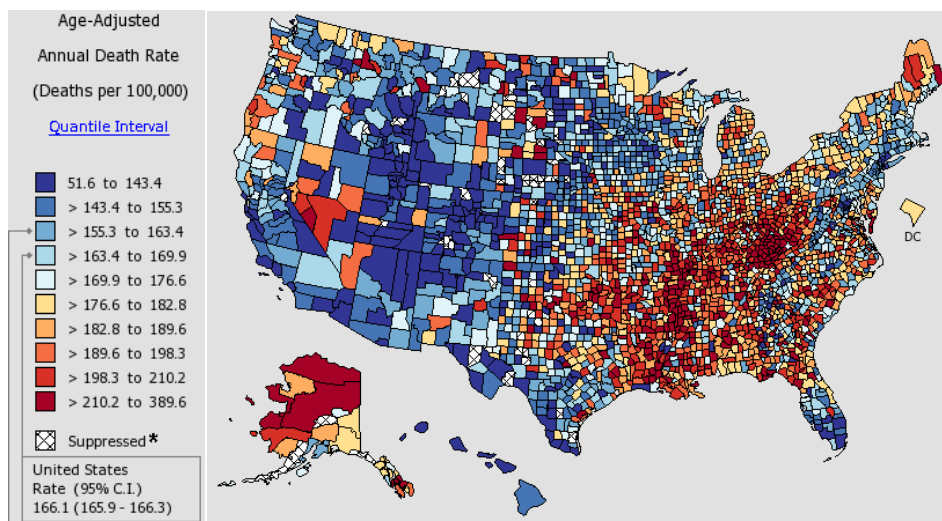


Figure 3: Cancer death rates by counties in US. [5]

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 to the carcinogenic aspects of oxygen itself (reduced by altitude, naturally) [6], in the case of lung 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* [7] 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

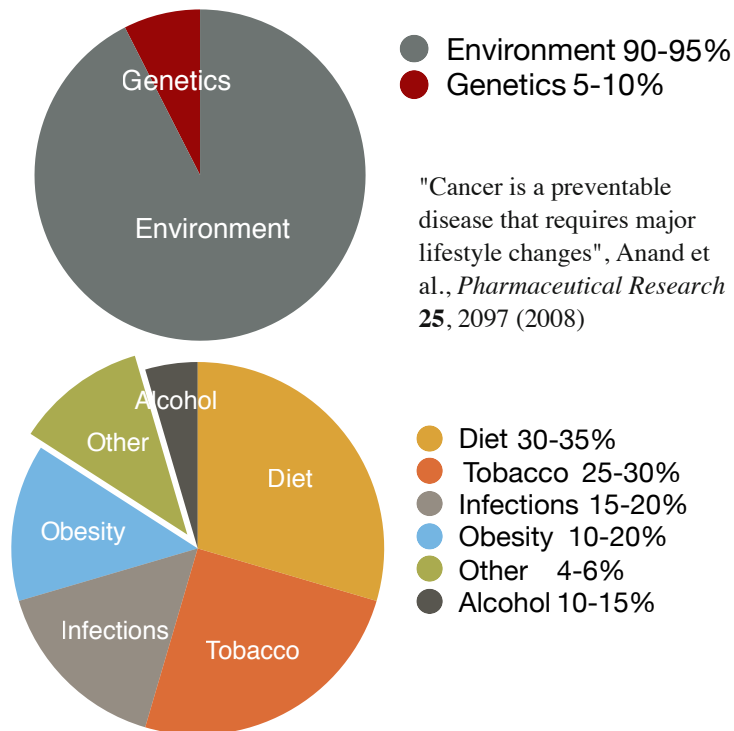


Figure 4: Estimated environmental vs. genetic contributions to cancer risk, top panel; estimated environmental (non-genetic) contributions to cancer risk, lower panel.

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 subsumed 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 [9]] 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, abnor-

It is perhaps surprising that infections are an important contribution to cancer. In an article published in 2012 [8] 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.

mal cholesterol and/or triglyceride blood levels. 13 particular cancers [10] are specifically associated with being obese or overweight.

As of November 2023, the results of a Danish [11] provide recent Danish data on the multiple lifestyle choices which affect cancer rates. These are reported in the website document *Careful radiation epidemiology*. Citations above are probably somewhat long in the tooth. Other website documents consider the epidemiology for people living around Rocky Flats in much more detail.

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

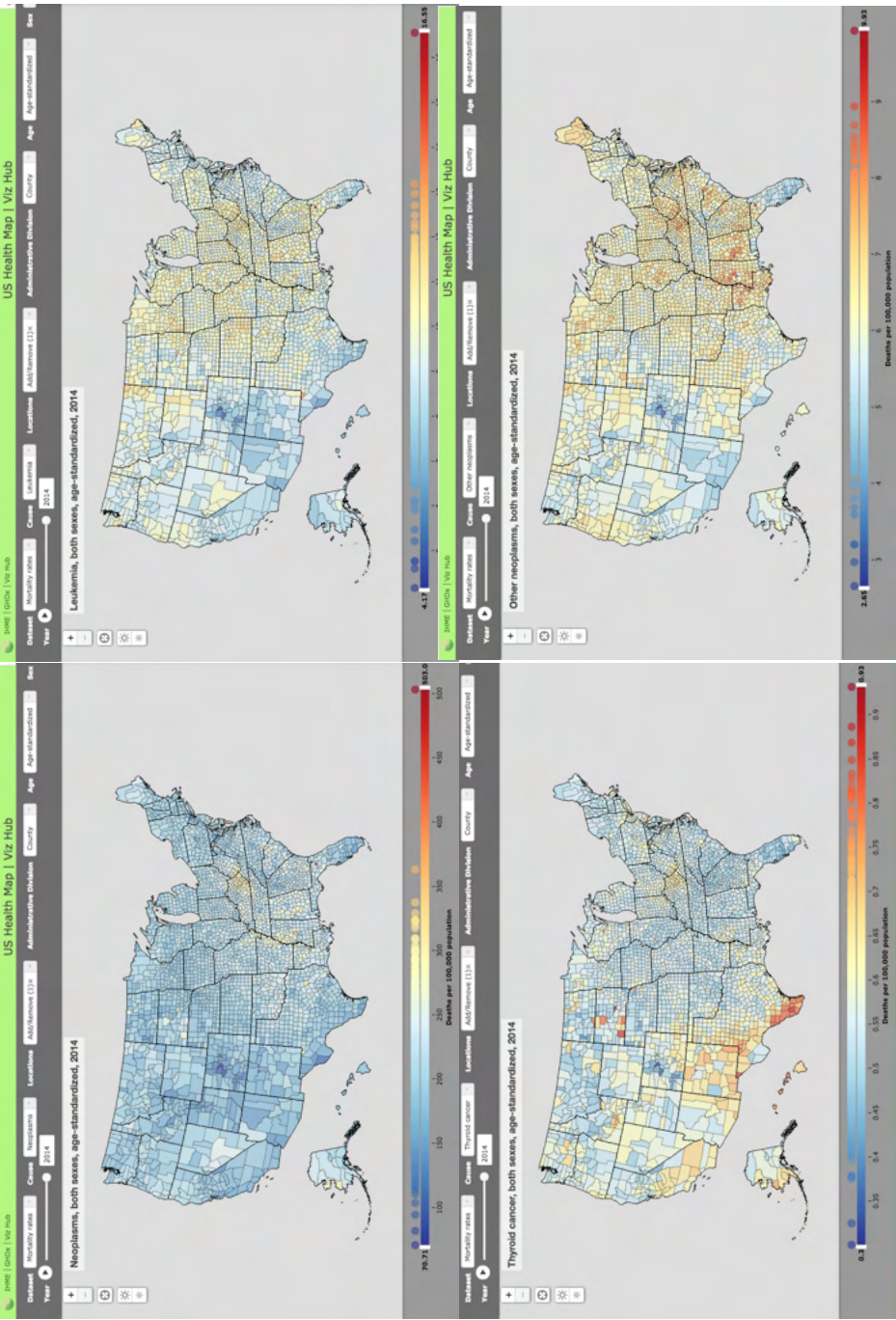


Figure 5: Death rates due to all cancers, leukemia, thyroid, and unusual cancers, by county in US as of 2014. [12]

your children's risk of lifetime cancer, make sure they are inoculated against diseases which under some circumstances cause cancer (e.g., HPV).

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- [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).
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