

\*From Edward Tufte's  
*The Visual Display of Quantitative Information*

### Data Maps






These six maps report the age-adjusted death rate from various types of cancer for the 3,056 counties of the United States. Each map portrays some 21,000 numbers.<sup>1</sup> Only a picture can carry such a volume of data in such a small space. Furthermore, all that data, thanks to the graphic, can be thought about in many different ways at many different levels of analysis—ranging from the contemplation of general overall patterns to the detection of very fine county-by-county detail. To take just a few examples, look at the

- high death rates from cancer in the northeast part of the country and around the Great Lakes
- low rates in an east-west band across the middle of the country
- higher rates for men than for women in the south, particularly Louisiana (cancers probably caused by occupational exposure, from working with asbestos in shipyards)
- unusual hot spots, including northern Minnesota and a few counties in Iowa and Nebraska along the Missouri River
- differences in types of cancer by region (for example, the high rates of stomach cancer in the north-central part of the country—probably the result of the consumption of smoked fish by Scandinavians)
- rates in areas where you have lived.

The maps provide many leads into the causes—and avoidance—of cancer. For example, the authors report:

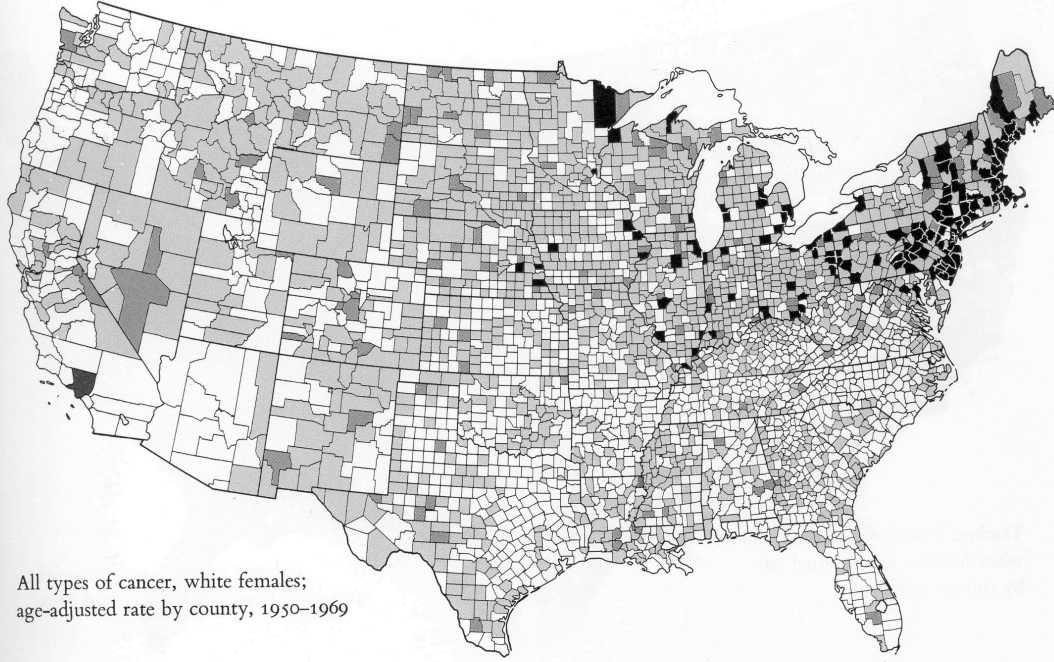
In certain situations . . . the unusual experience of a county warrants further investigation. For example, Salem County, New Jersey, leads the nation in bladder cancer mortality among white men. We attribute this excess risk to occupational exposures, since about 25 percent of the employed persons in this county work in the chemical industry, particularly the manufacturing of organic chemicals, which may cause bladder tumors. After the finding was communicated to New Jersey health officials, a company in the area reported that at least 330 workers in a single plant had developed bladder cancer during the last 50 years. It is urgent that surveys of cancer risk and programs in cancer control be initiated among workers and former workers in this area.<sup>2</sup>

<sup>1</sup>Each county's rate is located in two dimensions and, further, at least four numbers would be necessary to reconstruct the size and shape of each county. This yields  $7 \times 3,056$  entries in a data matrix sufficient to reproduce a map.

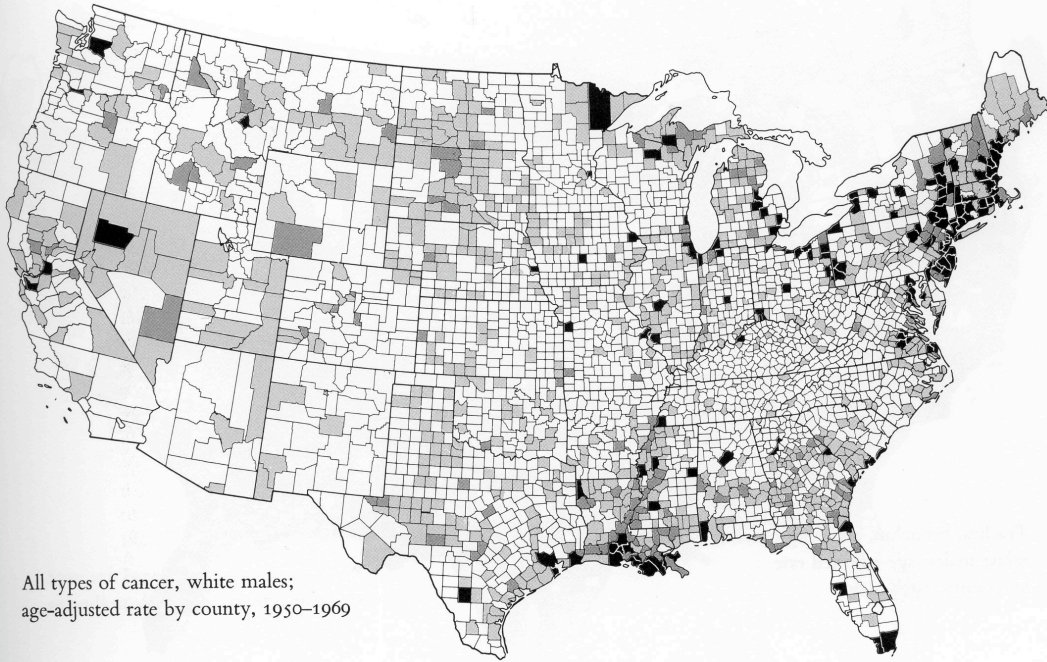
In highest decile, statistically significant	
Significantly high, but not in highest decile	
In highest decile, but not statistically significant	
Not significantly different from U.S. as a whole	
Significantly lower than U.S. as a whole	

<sup>2</sup>Robert Hoover, Thomas J. Mason, Frank W. McKay, and Joseph F. Fraumeni, Jr., "Cancer by County: New Resource for Etiologic Clues," *Science*, 189 (September 19, 1975), 1006.

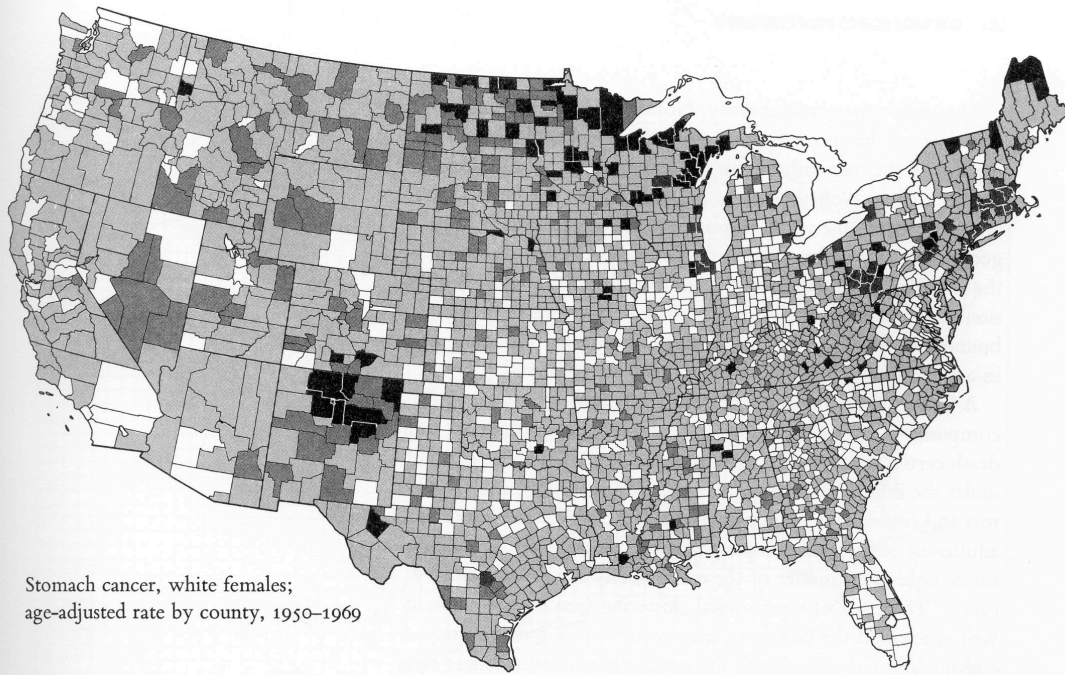
Maps from *Atlas of Cancer Mortality for U.S. Counties: 1950–1969*, by Thomas J. Mason, Frank W. McKay, Robert Hoover, William J. Blot, and Joseph F. Fraumeni, Jr. (Washington, D.C.: Public Health Service, National Institutes of Health, 1975). The six maps shown here were redesigned and redrawn by Lawrence Fahey and Edward Tufte.



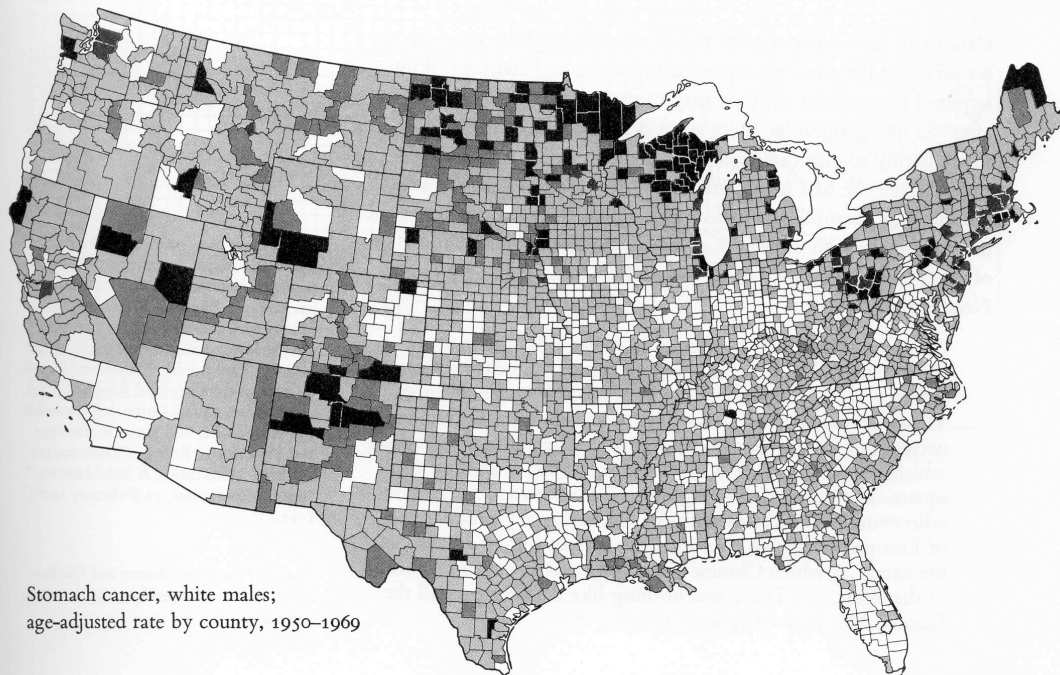
All types of cancer, white females;  
age-adjusted rate by county, 1950–1969



All types of cancer, white males;  
age-adjusted rate by county, 1950–1969



Stomach cancer, white females;  
age-adjusted rate by county, 1950–1969



Stomach cancer, white males;  
age-adjusted rate by county, 1950–1969

The maps repay careful study. Notice how quickly and naturally our attention has been directed toward exploring the substantive content of the data rather than toward questions of methodology and technique. Nonetheless the maps do have their flaws. They wrongly equate the visual importance of each county with its geographic area rather than with the number of people living in the county (or the number of cancer deaths). Our visual impression of the data is entangled with the circumstance of geographic boundaries, shapes, and areas—the chronic problem afflicting shaded-in-area designs of such “blot maps” or “patch maps.”

A further shortcoming, a defect of data rather than graphical composition, is that the maps are founded on a suspect data source, death certificate reports on the cause of death. These reports fall under the influence of diagnostic fashions prevailing among doctors and coroners in particular places and times, a troublesome adulterant of the evidence purporting to describe the already sometimes ambiguous matter of the exact bodily site of the primary cancer. Thus part of the regional clustering seen on the maps, as well as some of the hot spots, may reflect varying diagnostic customs and fads along with the actual differences in cancer rates between areas.

Data maps have a curious history. It was not until the seventeenth century that the combination of cartographic and statistical skills required to construct the data map came together, fully 5,000 years after the first geographic maps were drawn on clay tablets. And many highly sophisticated geographic maps were produced centuries before the first map containing any statistical material was drawn.<sup>3</sup> For example, a detailed map with a full grid was engraved during the eleventh century A.D. in China. The Yü Chi Thu (Map of the Tracks of Yü the Great) shown here is described by Joseph Needham as the

. . . most remarkable cartographic work of its age in any culture, carved in stone in +1137 but probably dating from before +1100. The scale of the grid is 100 *li* to the division. The coastal outline is relatively firm and the precision of the network of river systems extraordinary. The size of the original, which is now in the Pei Lin Museum at Sian, is about 3 feet square. The name of the geographer is not known. . . . Anyone who compares this map with the contemporary productions of European religious cosmography cannot but be amazed at the extent to which Chinese geography was at that time ahead of the West. . . . There was nothing like it in Europe till the Escorial MS. map of about +1550. . . .<sup>4</sup>

<sup>3</sup>Data maps are usually described as “thematic maps” in cartography. For a thorough account, see Arthur H. Robinson, *Early Thematic Mapping in the History of Cartography* (Chicago, 1982). On the history of statistical graphics, see H. Gray Funkhouser, “Historical Development of the Graphical Representation of Statistical Data,” *Osiris*, 3 (November 1937), 269–404; and James R. Beniger and Dorothy L. Robyn, “Quantitative Graphics in Statistics: A Brief History,” *American Statistician*, 32 (February 1978), 1–11.

<sup>4</sup>Joseph Needham, *Science and Civilisation in China* (Cambridge, 1959), vol. 3, 546–547.