Production of Health

Chapter 5

Chapter Outline

- The Production Function of Health
- The Inputs into the Production of Health
- The Role of the Government
- Conclusions

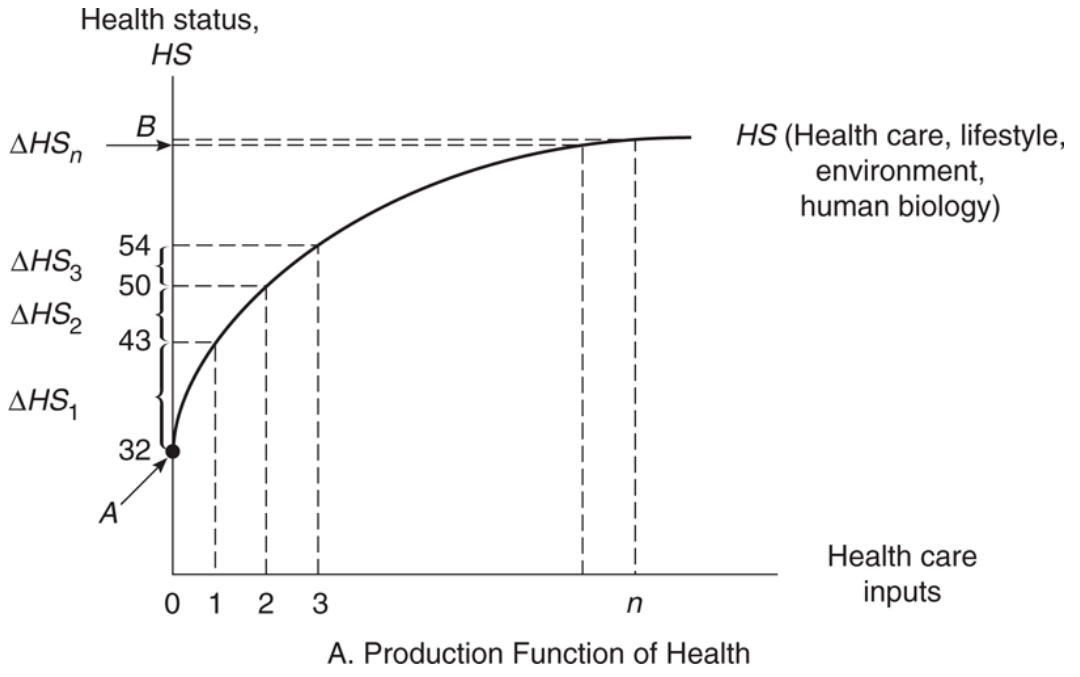
THE PRODUCTION FUNCTION OF HEALTH
Definition

- The production function of health defines the relationship health and the health inputs needed to produce health.

Total Product

- Health status increases as more and more health care inputs are added to the production process.

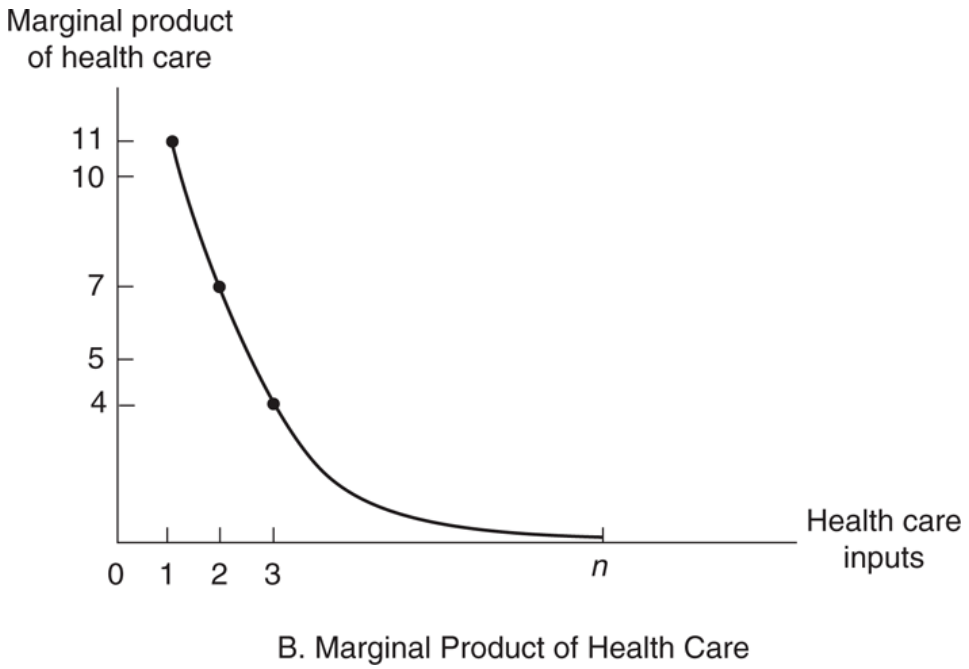
Figure 5-1 Production of Health A



Marginal Product

- Diminishing marginal product – as more and more health care inputs are added to the production process, the increments in heath status diminish.

Figure 5-1 Production of Health B



B. Marginal Product of Health Care

Marginal Product and Health Care Policy

- From the perspective of public policy the marginal product is most relevant. For example, would it be better to reduce health care expenditures by $1 billion and invest those funds in another productive use, such as housing, education, or environmental programs?
  - The extra dollar should go to where the marginal product is highest.

- In a developed economy the marginal product of healthcare spending is likely to much lower than in a developing economy.
    - In a developed economy you would probably be on the flat portion of the production function, so the marginal product is low
    - In a developing economy you would probably be on the increase part of the production function, so marginal product is high
  - As healthcare spending increases the marginal product falls

The Production of Health

- Health=f(Medical Care, Lifestyle, Environment, Human Biology)
- Produce health with inputs: Medical care, Lifestyle, Environment and Human Biology

Measuring Outputs

- Health status is the output, but the issue is how to measure it.
- There are many alternative measures, but we'll focus on two:
  - Mortality: the number of deaths per 100000 of the population
  - Morbidity: the number of persons who have an illness or disease per 100000 of the population

COVID-19 Morbidity and Mortality Rates for Selected Provinces, July 2020

	Number of Cases	Number of Deaths	Population	Morbidity Rate	Mortality Rate
PEI	36	0	158,171	22.76	0.00
Nova Scotia	1066	63	978,274	108.97	6.44
Quebec	56873	5632	8,552,362	665.00	65.85
Ontario	36949	2761	14,745,040	250.59	18.72
Manitoba	330	7	1,379,121	23.93	0.51
Alberta	8904	163	4,428,247	201.07	3.68
British Columbia	3133	188	5,120,184	61.19	3.67

COVID-19 Morbidity and Mortality Rates for Selected Provinces, Fall 2020

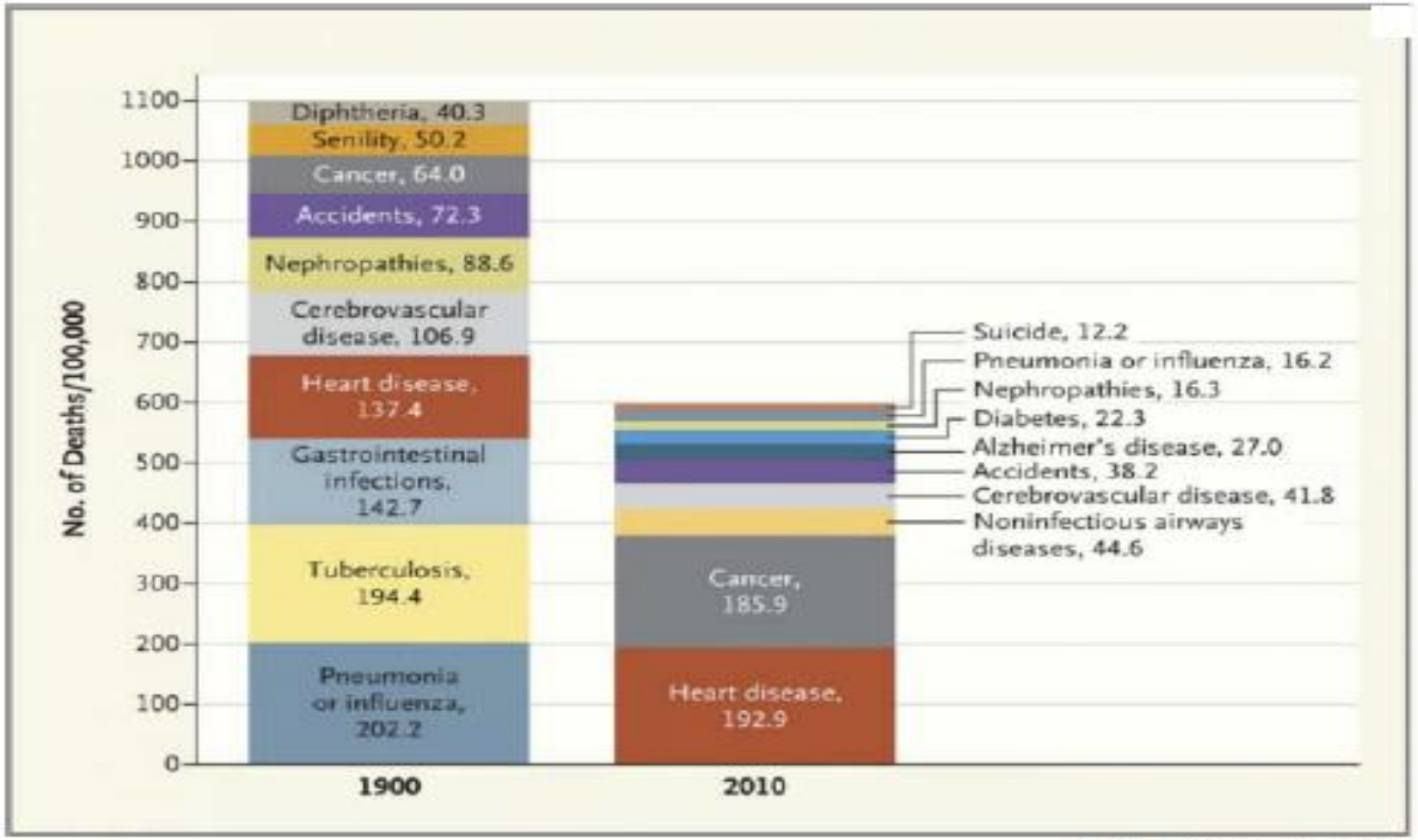
	Number of Cases	Number of Deaths	Population	Morbidity Rate	Mortality Rate
PEI	70	0	158171	44.26	0.00
Nova Scotia	1,227	65	978,274	125.42	6.64
Quebec	135,430	6,915	8,552,362	1583.54	80.85
Ontario	107,883	3,554	14745040	731.66	24.10
Manitoba	14,907	256	1379121	1080.91	18.56
Alberta	49,536	492	4428247	1118.64	11.11
British Columbia	28,348	358	5120184	553.65	6.99

COVID-19 Morbidity and Mortality Rates for Selected Provinces, July 2021

	Number of Cases	Number of Deaths	Population	Morbidity Rate	Mortality Rate
PEI	208	0	158171	131.50	0.00
Nova Scotia	5,870	92	978,274	600.04	9.40
Quebec	375,969	11,231	8,552,362	4396.08	131.32
Ontario	547,409	9,258	14745040	3712.50	62.79
Manitoba	56,937	1163	1379121	4128.50	84.33
Alberta	232,536	2310	4428247	5251.20	52.17
British Columbia	148,187	1760	5120184	2894.17	34.37

- Another output measure that is used to measure health is life expectancy, i.e., how long someone will live on average.
  - 80.62 years for men and 84.67 years for women in Canada in 2021; 80 years for men and 84 years for women in Canada, 2014; in 1990 would have been 74 for men and 81 for women
  - Generally research has found that life expectancy (both sexes) in countries like Canada (with high life expectancy) have increased at a linear rate of about 3 months per year since 1840.

Leading Causes of Death: 1900 vs 2010



The New England Journal Of Medicine

Influenza Mortality in the U.S. 1900-2018

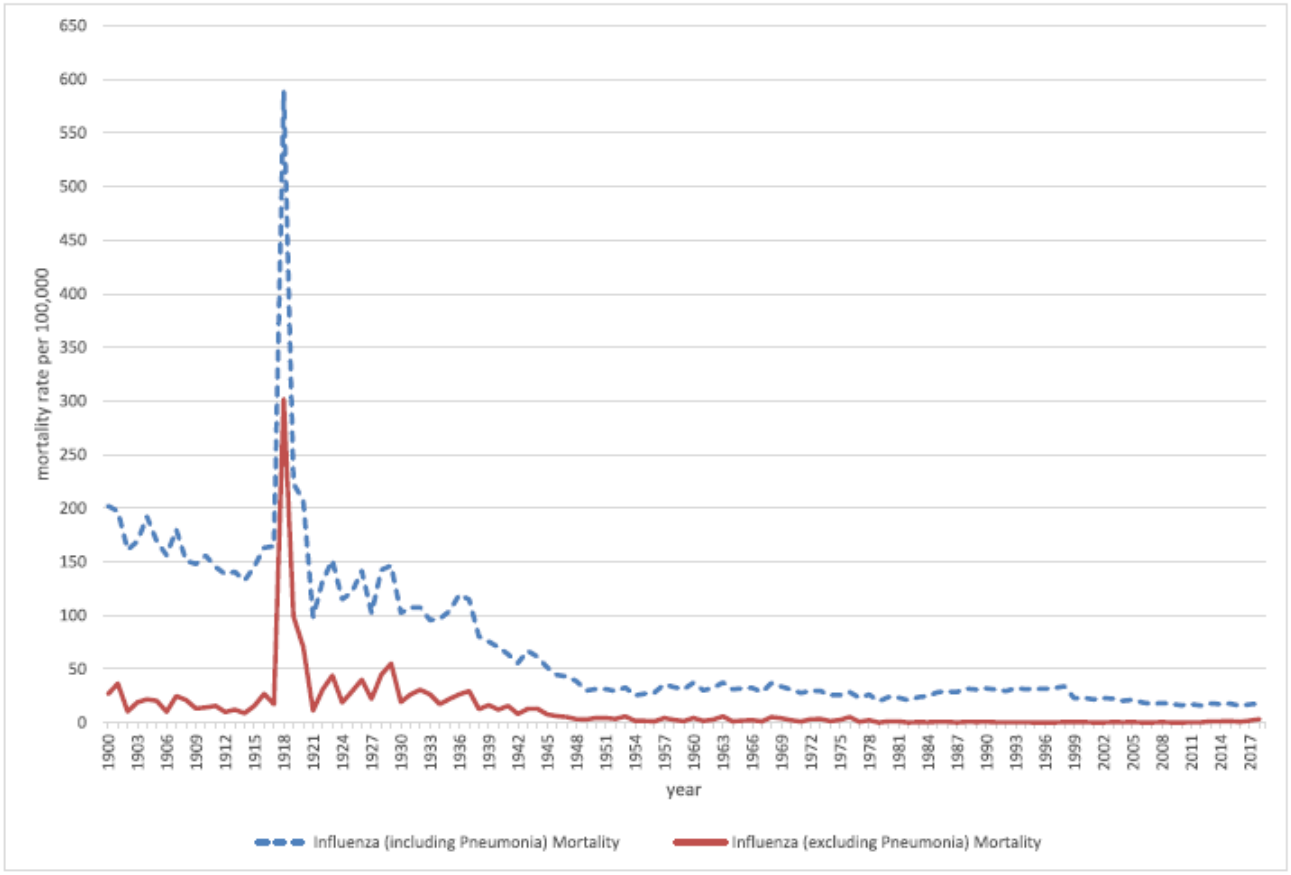


Fig. 1. Influenza mortality rates per 100,000, United States, 1900–2018

Medical Care

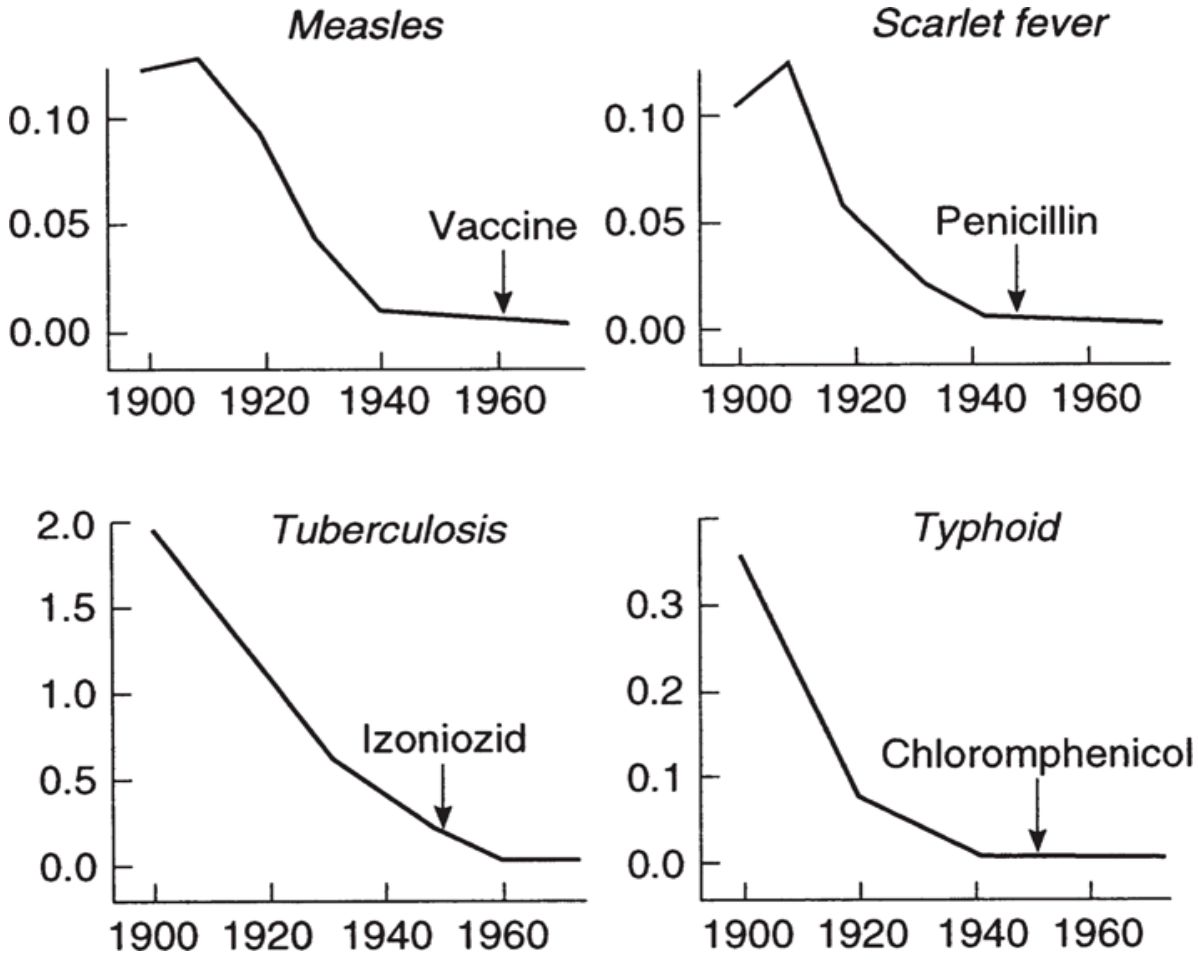
- This is an obvious input, and probably the one that most people would think would be the most important.
- However, medical care can also create some negative externalities (e.g., the inappropriate use of a tuberculosis test can make people worse off; opioid addiction because of pain management; side effects of some medical treatments).

Medical Care

- Many medical historians agree that practitioner-provided medical interventions played only a small, perhaps negligible, role in the historical decline in population mortality rates. Consider the following diagrams:

Did Medicine Cause the Decline in Mortality Rates?

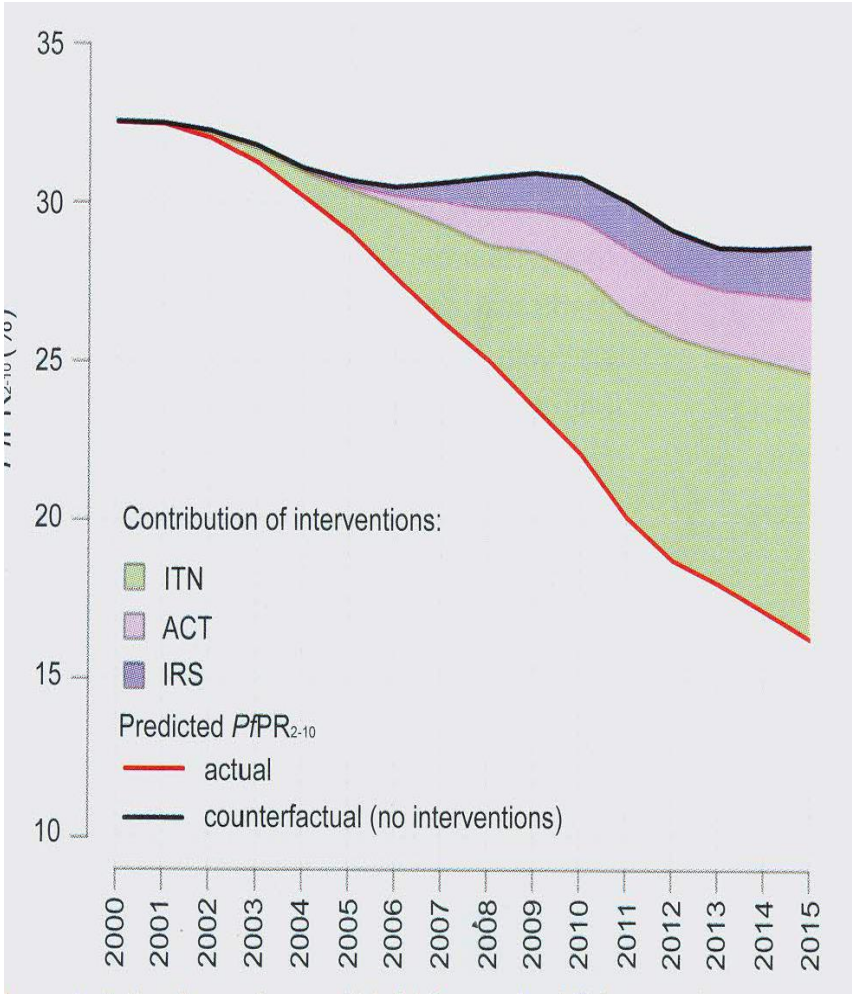
Figure 5-3 Fall in the Standardized Death Rate per 1,000 Population for Four Common Infectious Diseases in Relation to Specific Medical Measures for the United States



Source: Reprinted from Milbank Memorial Fund Quarterly/Health and Society, John B. Mckinlay and Sonja M. Mckinlay, "The Questionable Contribution of Medical Measures to the Decline of Mortality in the United States in the Twentieth Century, *Milbank Memorial Fund Quarterly/Health and Society 55 (1977): 405–428, with the permission of* Blackwell Publishers.

Reducing the Impact of Malaria: Medical vs Other Interventions

- The diagram illustrates decline in malaria prevalence rates due to alternative interventions for children aged 2-10 in sub-Saharan Africa
  - ITN: insecticide treated bed nets
  - IRS: indoor residual spraying of insecticides
  - ACT: artemisin-based combination therapy



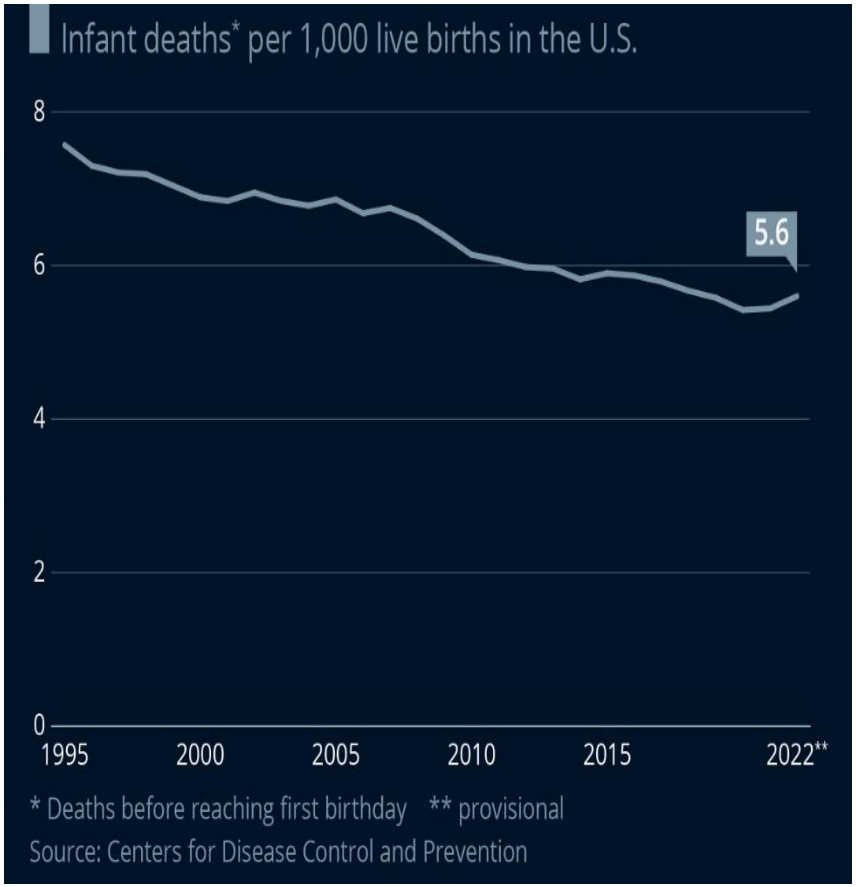
Medical Care

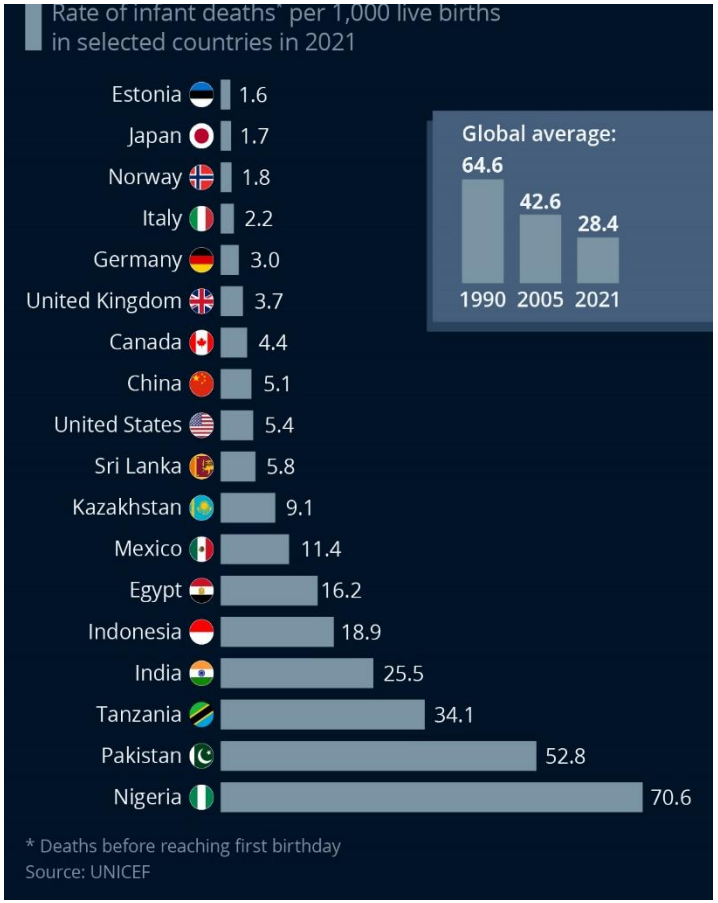
- These graphs indicate that most of the major declines in the prevalence of many infectious diseases occurred before the introduction of drugs used to treat them.
- What could explain declines in the figures?
  - Public health initiatives, e.g., clean drinking water
  - Nutrition, i.e., higher calorie intake,
    - e.g., Fogel calculated that between 1785 and 1870 better nutrition accounted for 90% of the reduction in mortality rates during that period and 50% of the reduction in mortality rates between 1870 and 1975.

Medical Care and Infant Mortality

- Where medical care is most effective is at really young ages, i.e., less than 1 year and especially less than 1 month (neonatal) since the death rates at these ages have decreased dramatically.

Infant Mortality Rates: US and Selected countries





Medical Care

- Medical care has also been very effective in treating bacterial and viral infections, e.g., sulfa drugs which were used to treat bacterial infections before antibiotics, are thought to have increased life expectancy by 0.4 to 0.8 years between 1937 and 1943;
- treatments for high blood pressure, led massive declines in mortality from heart disease after 1970;
- rehydration therapy for diarrhea reduced death rates for cholera after 1973 (especially in developing countries).

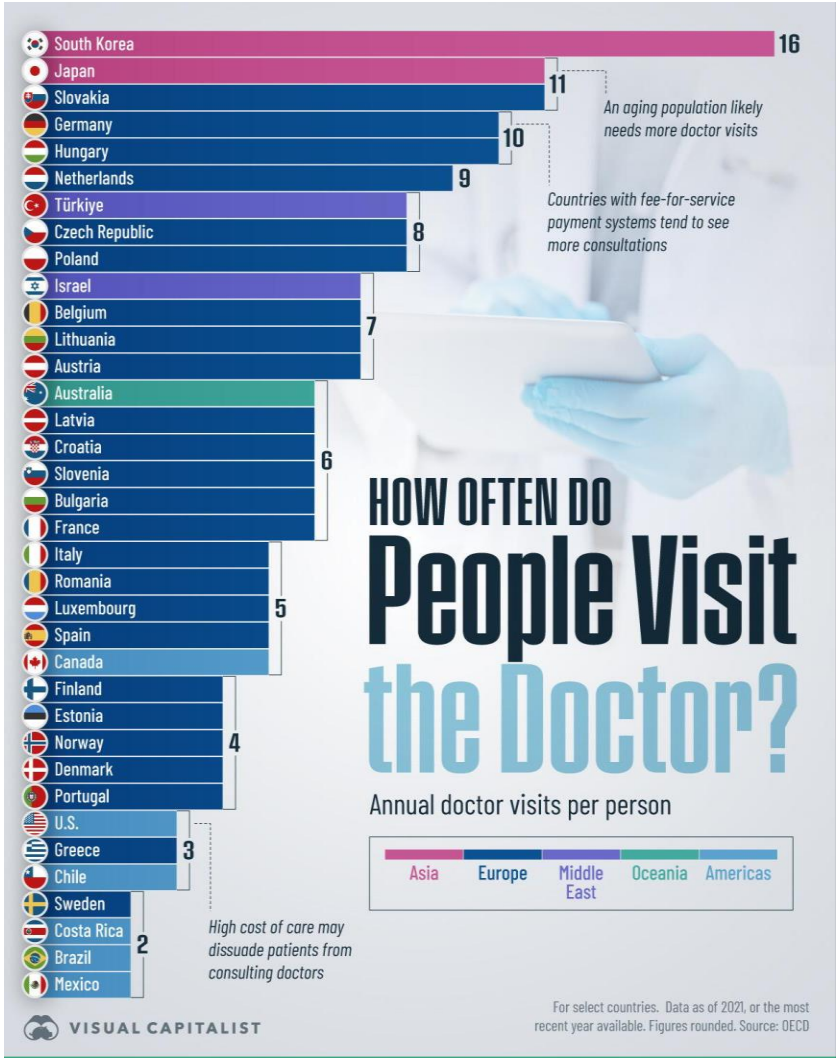
Medical Care

- Medical care also matters more at older ages, where the incidence of heart disease and cancer is much higher. Generally, treatments for heart disease and cancer have improved, although with cancer much really depends on the pathology of the tumors (some types of cancers are easier to treat than others).

Medical Care

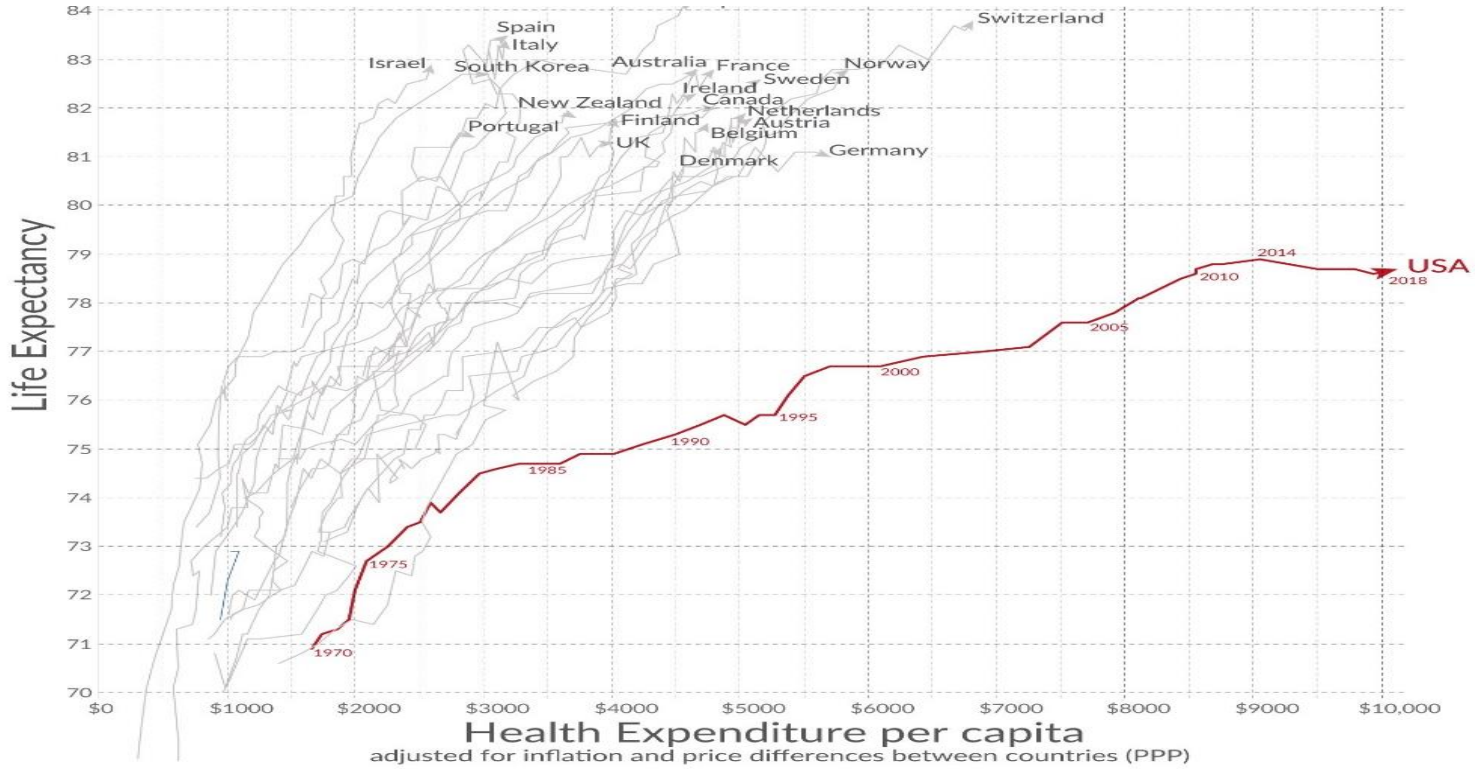
- Research suggests that the elasticity of health care at the margin is 0.10 in the U.S.
- Another calculation based on U.S. data, is that given current levels of expenditure on health care, a $100 billion expenditure on health care would result in an increase in life expectancy of 0.76 years spread over the population.
- Both sets of estimates are consistent with medical care having a small marginal product

Medical Care



- A great deal of range in usage (annual number of visits):
  - US: 3
  - Canada, Spain, Italy: 5
  - South Korea: 16
  - Japan: 11

Medical Care Expenditures vs Life Expectancy



Lifestyle

- Lifestyle factors are sometimes called preventive measures, e.g., you have a healthy lifestyle and it makes you less likely to need medical care.
- Lifestyle factors can also be complementary for medical care, e.g., if you have diabetes you might get nutrition counseling as well as instructions about exercise; if you have heart disease you might be asked to cut back on saturated fats, sodium and cholestrol.

Lifestyle

- This generally includes nutrition and exercise.
- Smoking would also be a lifestyle factor;

Lifestyle

- Alcohol consumption can also be a risk factor, especially excessive consumption, for liver disease as well as heart disease and digestive problems among other problems
- Occupations can matter, some workers can be exposed to hazardous materials at work and this can increase their risk of health problems

Lifestyle

- Drug addiction can also have an effect on health
  - For example, intravenous drug users (e.g., heroine, cocaine) can have higher rates of HIV/AIDS and Hepatitis infections
  - Drug users often have higher rates of emergency room visits (overdose and other problems), which can be a cost to society.
- Education can also play a role.

Lifestyle

- Socioeconomic Status and Health;
  - One stylized fact of health that is common to all countries in the world is that people with lower socioeconomic status have poorer health; this is often referred to as the “gradient in socioeconomic status”; while there is a great deal of evidence on the gradient the mechanism for how it works is not clear; e.g., could it be that lower socioeconomic status is correlated with lower levels of education (and it’s effect on health) or is it related to environmental factors …

Environment

- Where people live can matter for their health.
- Access to clean drinking water can reduce the spread of diseases such as cholera and dysentery
  - Cholera and dysentery kill many people in developing countries who do not have access to clean drinking water; These diseases used to kill a lot of people in Canada, U.S. and Europe before the big public health initiatives in the 19th century which started water purification as well as treating sewage before dumping it

- As an example of the effects of cleaner and higher quality drinking water on mortality rates; Cutler and Miller estimated that for U.S. cities between 1900 and 1936 water filtration and chlorination accounted for about 43% of the decline in mortality rates during that time in those U.S. cities.

Environment

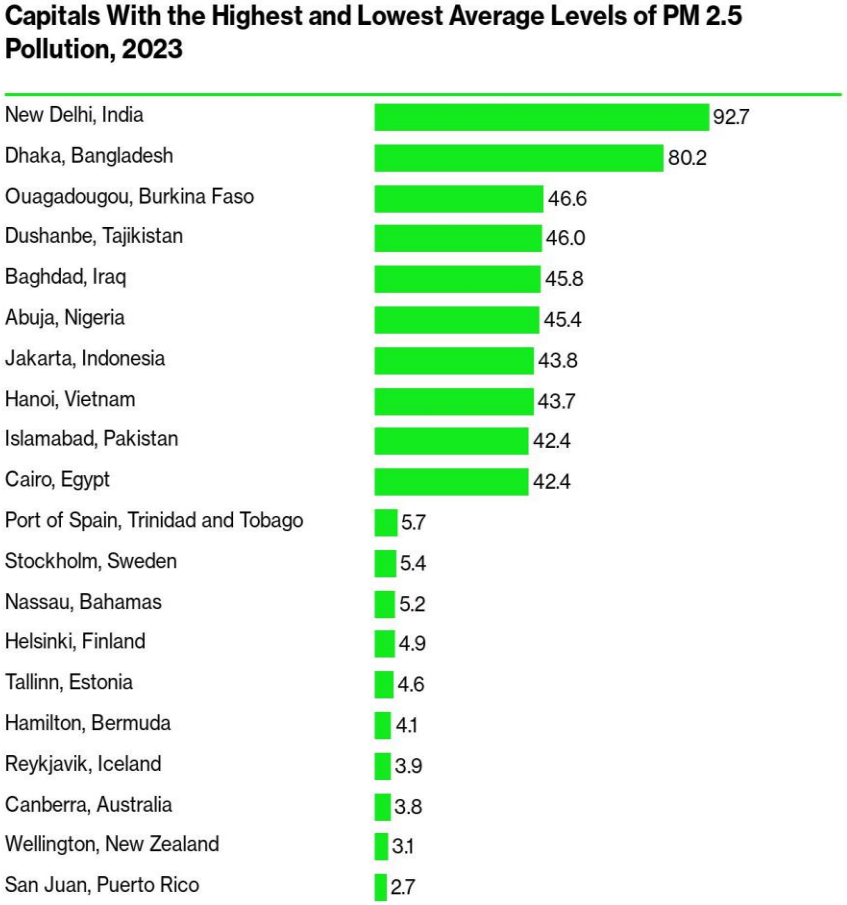
- From a historical perspective, there used to a difference in mortality between rural and urban areas (rural areas had lower mortality rates, some of this could be attributed to access to better drinking water); today urban areas can have higher rates of air pollution and this can lead to greater incidence of respiratory problems or emergency room visits for people with Asthma

Environment

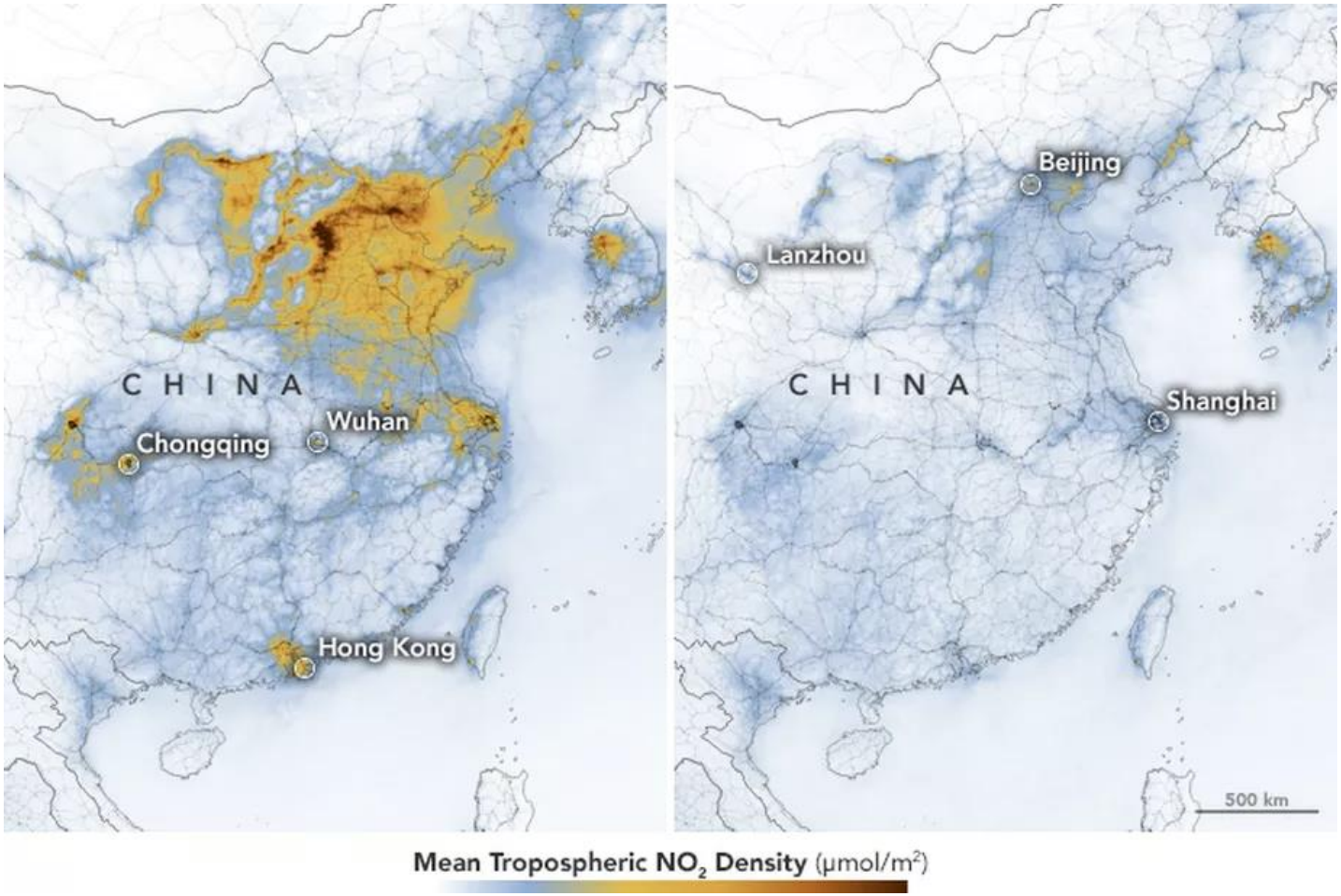
- There are a number of measures of air quality, one is the Air Quality Index, which includes a measurement known as the PM2.5, quantifies the concentration of particles less than 2.5 micrometers (e.g., sulphates, nitrogen dioxide, ozone) which are thought to have adverse effects on health; when inhaled these small particles can increase risk of heart attacks, cancer and acute respiratory infections, especially in children and the elderly.

Environment

- The World Health Organization (W.H.O.) guidelines on particulate matter sets a target of 10 for the PM2.5 as an upper bound on the safe level;
  - In Toronto, average PM2.5 during 2022 is 8.5
  - In Miami, average PM2.5 during 2022 is 6.4
  - In Roma, average PM2.5 during 2022 is 12.6
  - In Beijing, average PM2.5 during 2022 is 29.8
  - In New Delhi, average PM2.5 during 2022 is 92.6



Air Quality in China: Before COVID-19 and During Lockdown



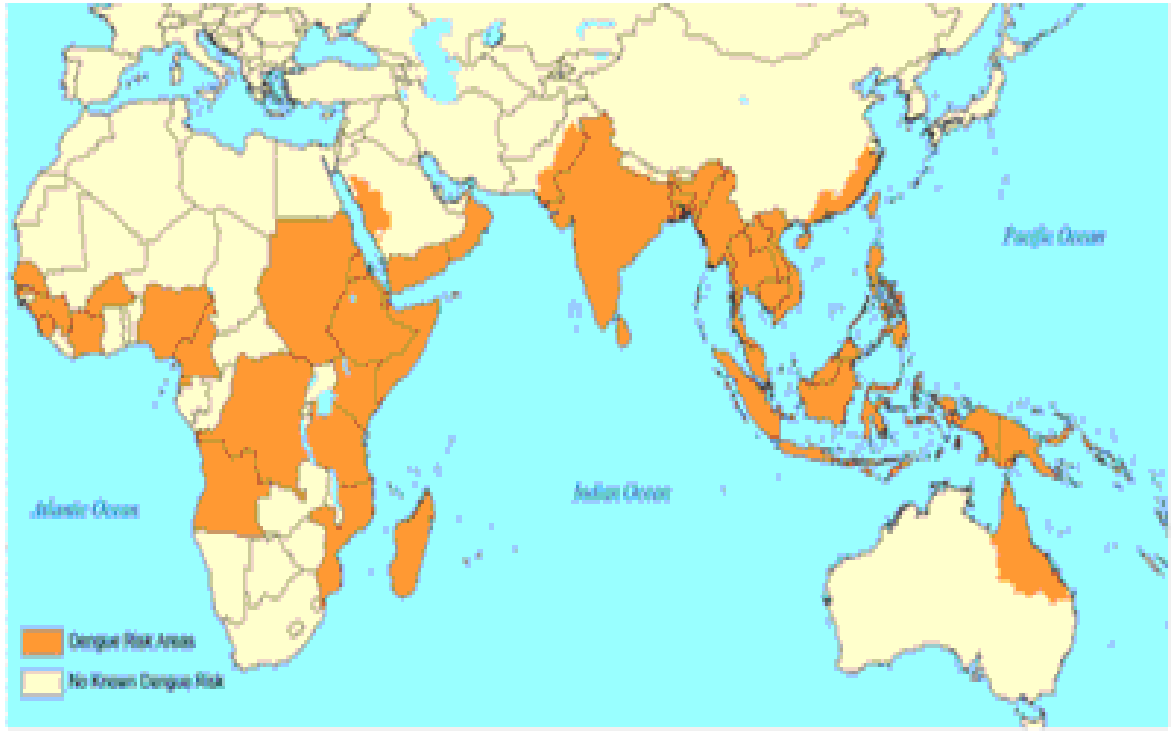
Environment

- Another environmental factor can be the control of mosquito borne diesases;
  - Malaria, used to be a problem in the southern U.S. states as well as southern Europe; solution was to drain marshland and swamps, where mosquitoes are in large concentration,
  - West Nile Virus, great concern in North America; generally leave pesticides in storm catch basins as well as advising people to not have water standing around their houses

Environment

- Dengue Fever, another mosquito borne disease, is becoming more a concern in the U.S.; Dengue Fever has been spreading around the world.

Spread of Dengue Fever



Human Biology

- Genetics; inter-generational links for some diseases, e.g., some forms of cancer, heart disease, some mental health disorders
- Differences by gender in some diseases; e.g., some blood disorders (low platelet count may be more common in women) and race (black men have a higher risk of prostrate cancer, south asians have a higher risk of diabetes)
- Not much that can be done about genetics, except get treatment

The Role of the Government

- In most (developed) countries the government plays a larger role in the production of health.
- In terms of medical care, the government is involved in provided medical care, whether paying for it with taxes or with subsidies to individuals in almost all developed countries
- However, the government can also have effects on the other inputs, except for human biology.

Public Health vs Health Promotion

- Public Health
  - Sewage Treatment and water purification
  - Quarantines; Social Distancing
  - Controlling Mosquito borne diseases
  - Controlling pollution to maintain the quality of drinking water and air quality
  - Food safety
- Health Promotion
  - Promoting Healthy lifestyles, better nutrition and getting people to exercise more
  - Controlling smoking and excessive alcohol consumption
  - Raising awareness about diseases or vacation programs (like those for the flu or children)

Public Health vs Health Promotion

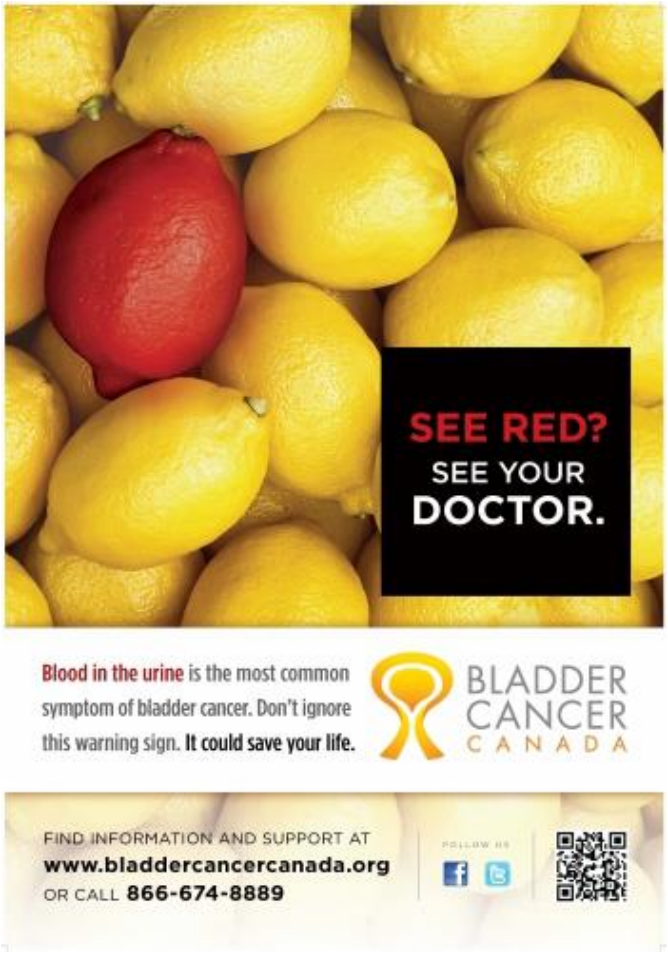
- Public health programs include government initiatives to provide clean drinking water and immunization programs.
- Health promotion is about bringing attention to some sort of illness (i.e., early screening or testing) or some sort of lifestyle changes that would improve health (better nutrition and more exercise).

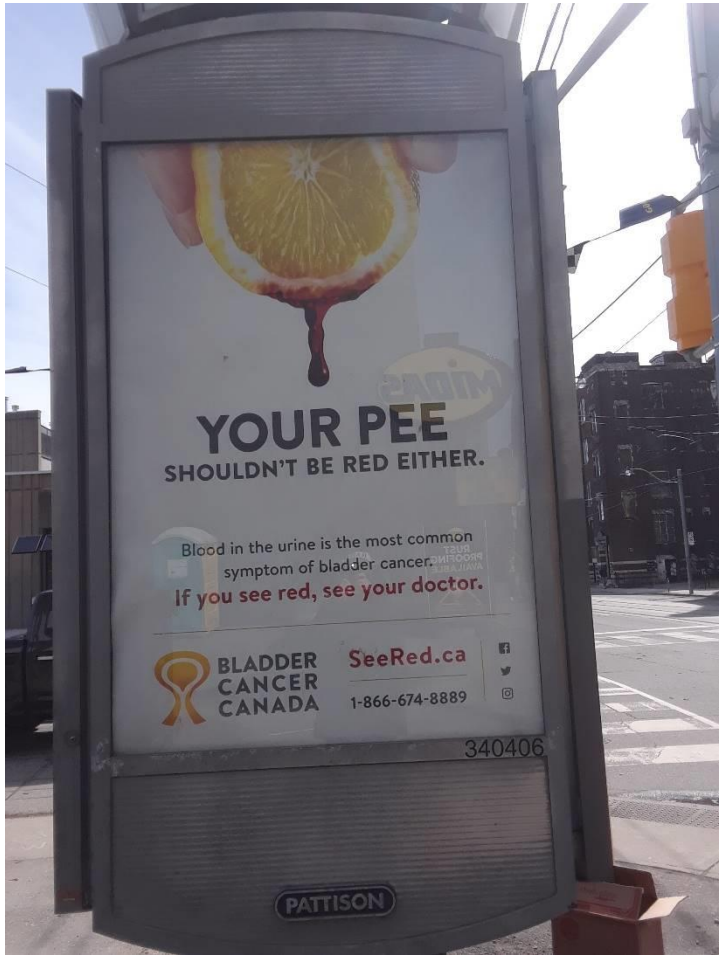
- All levels of government can engage in health promotion, and there are a number of ways they do so.
- Some use webpages, some examples might include https://www.participaction.com
  Focused on increasing exercise, particularly in children (reduce obesity and related health problems)

- Eating healthy https://www.canada.ca/en/services/health/food-nutrition.html
- Toronto Public Health https://www.toronto.ca/community-people/health-wellness-care/
  - Provides information on various clinics run by the city, immunization programs, and other programs the city offers.

- Health promotion can be a little broader than the government though, sometimes other non-profit organizations can be involved as can some private organizations, and they may even partner with the government.
- In addition, to websites health promotion is often facilitated through advertising in magazines or outdoors or on public transportation or even with product warnings.

Examples of ads raising awareness: Bladder Cancer





Examples of ads raising awareness: Vacination

Pointing out health risks: Cigarette Package Warning Labels

- Generally, public health programs are focused on environmental factors in terms of the inputs used to produce health
- Health promotion is mostly targeted to lifestyle factors, although it can also increase the use of medical care if it is about raising the awareness or highlighting the symptoms of some health problem.

What is Bottomline?

- It’s tricky to sort out what the most factor for producing health because of uncertainty, a lot of things might produce the patterns we see in the data.