Epidemiological Transition and Global Burden of Diseases Measures

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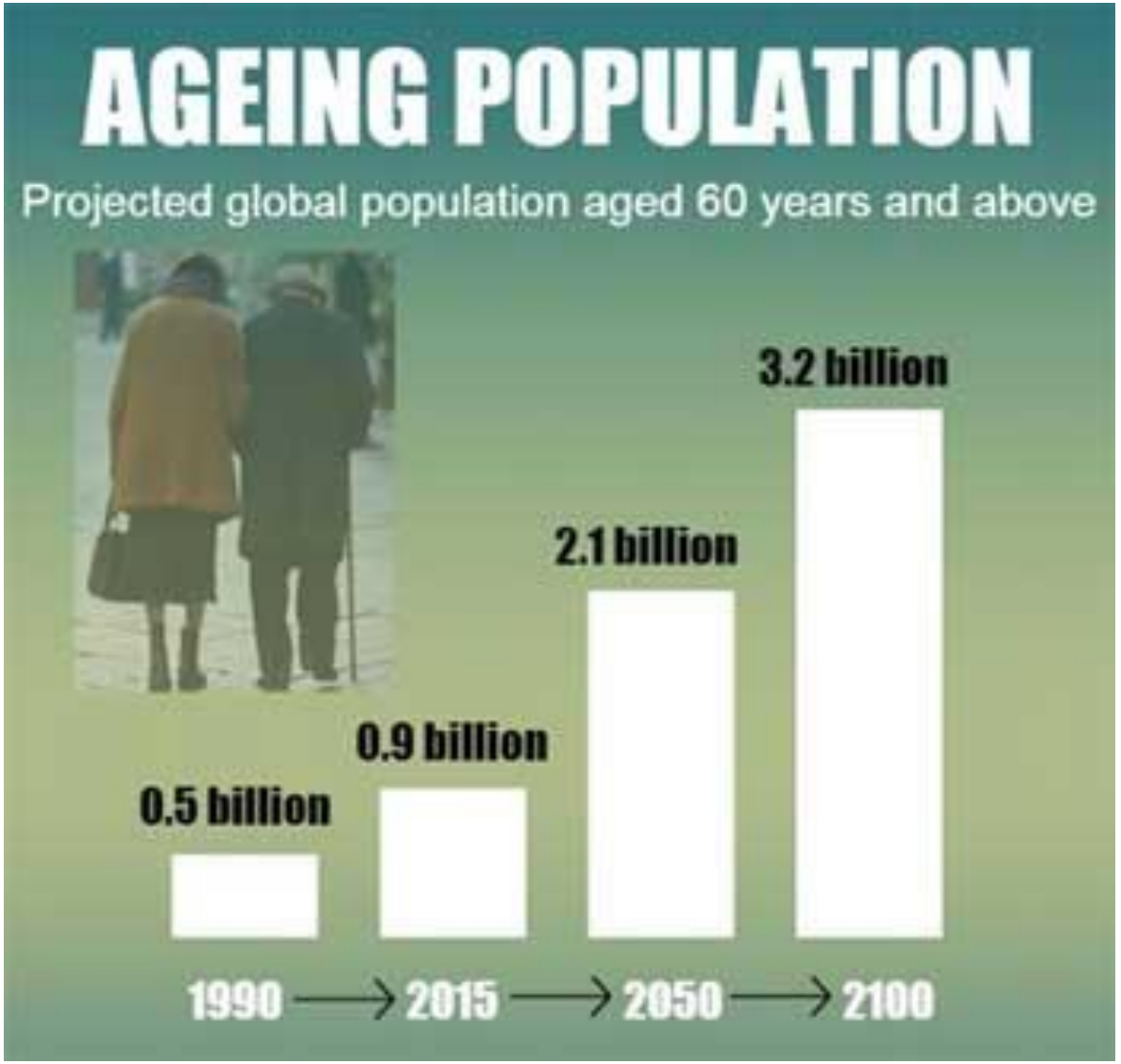
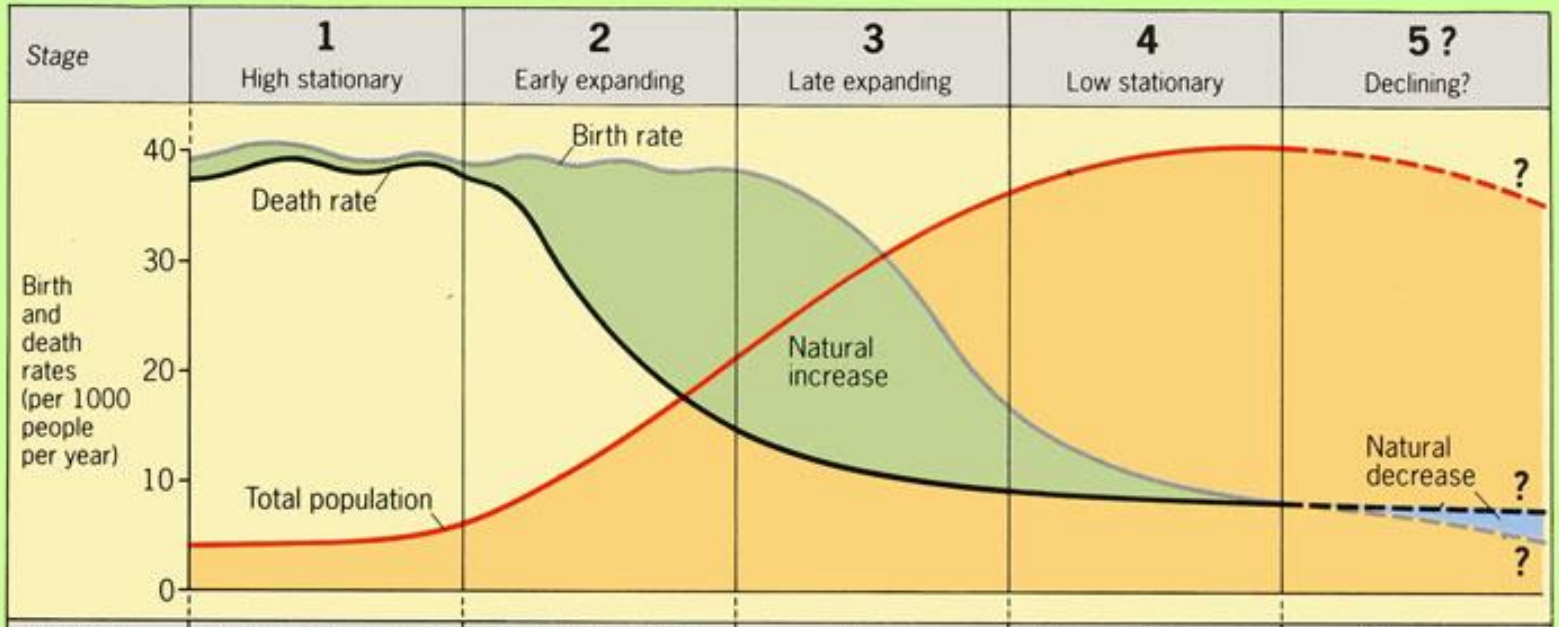
Aging world

- Globally, people aged 60 or over are increasing faster than all younger age groups.
- Europe has the greatest percentage of population aged 60 and above (25%).
- The number of those aged 60 years and above is expected to be more than double by 2050 and to more than triple by 2100.

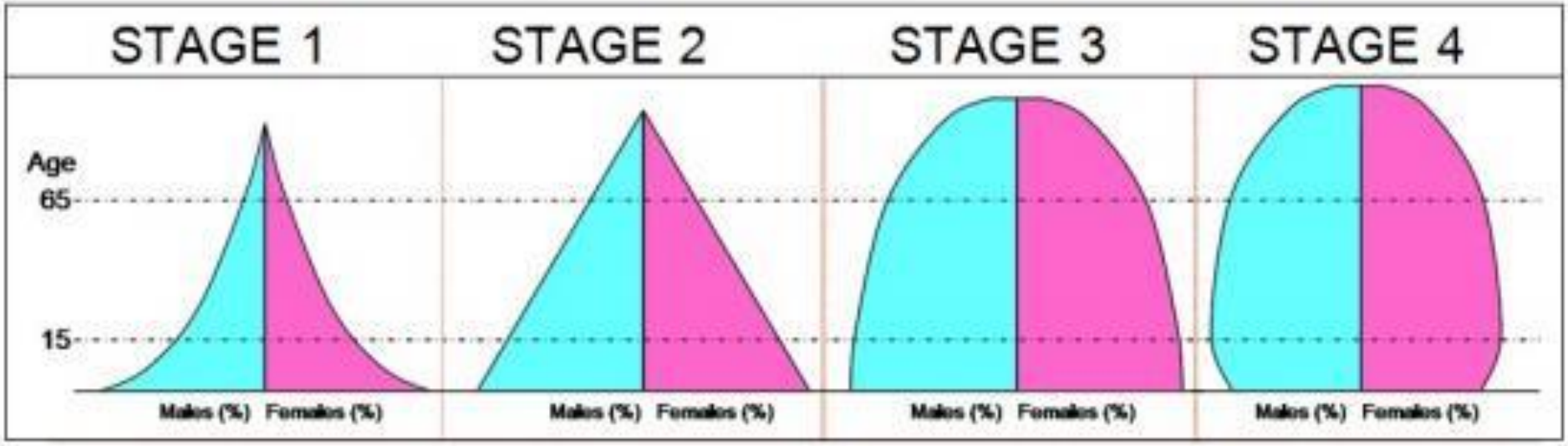


Data from [World Population Prospects: the 2017 Revision],

Demographic Transition Model



Stage	1 High stationary	2 Early expanding	3 Late expanding	4 Low stationary	5? Declining?
Examples	A few remote groups	Egypt, Kenya, India	Brazil	France and UK	Germany
Birth rate	High	High	Falling	Low	Very low
Death rate	High	Falls rapidly	Falls more slowly	Low	Low
Natural increase	Stable or slow increase	Very rapid increase	Increase slows down	Stable or slow increase	Slow decrease
Reasons for changes in birth rate	Many children needed for farming. Many children die at an early age. Religious/social encouragement. No family planning.		Improved medical care and diet. Fewer children needed.	Family planning. Good health. Improving status of women. Later marriages.	
Reasons for changes in death rate	Disease, famine. Poor medical knowledge so many children die.	Improvements in medical care, water supply and sanitation. Fewer children die.		Good health care. Reliable food supply.	



- **Stage 1 -** High birth rate. Rapid fall in each upward age group due to high death rates. Short life expectancy.
- **Stage 2 -** Still high birth rate. Fall in death rate as more living in middle age. Slightly longer life expectancy.
- **Stage 3 -** Declining birth rate and declining death rate. More people living to an older age.
- **Stage 4 -** Low birth rate and low death rate. High proportion of dependents. Longer life expectancy.

What is epidemiology?

- **Epidemiology is** a branch of medical science that studies the distribution of DISEASE in human populations and the factors that determines its distribution, principally by using STATISTICS.

Epidemiological transition

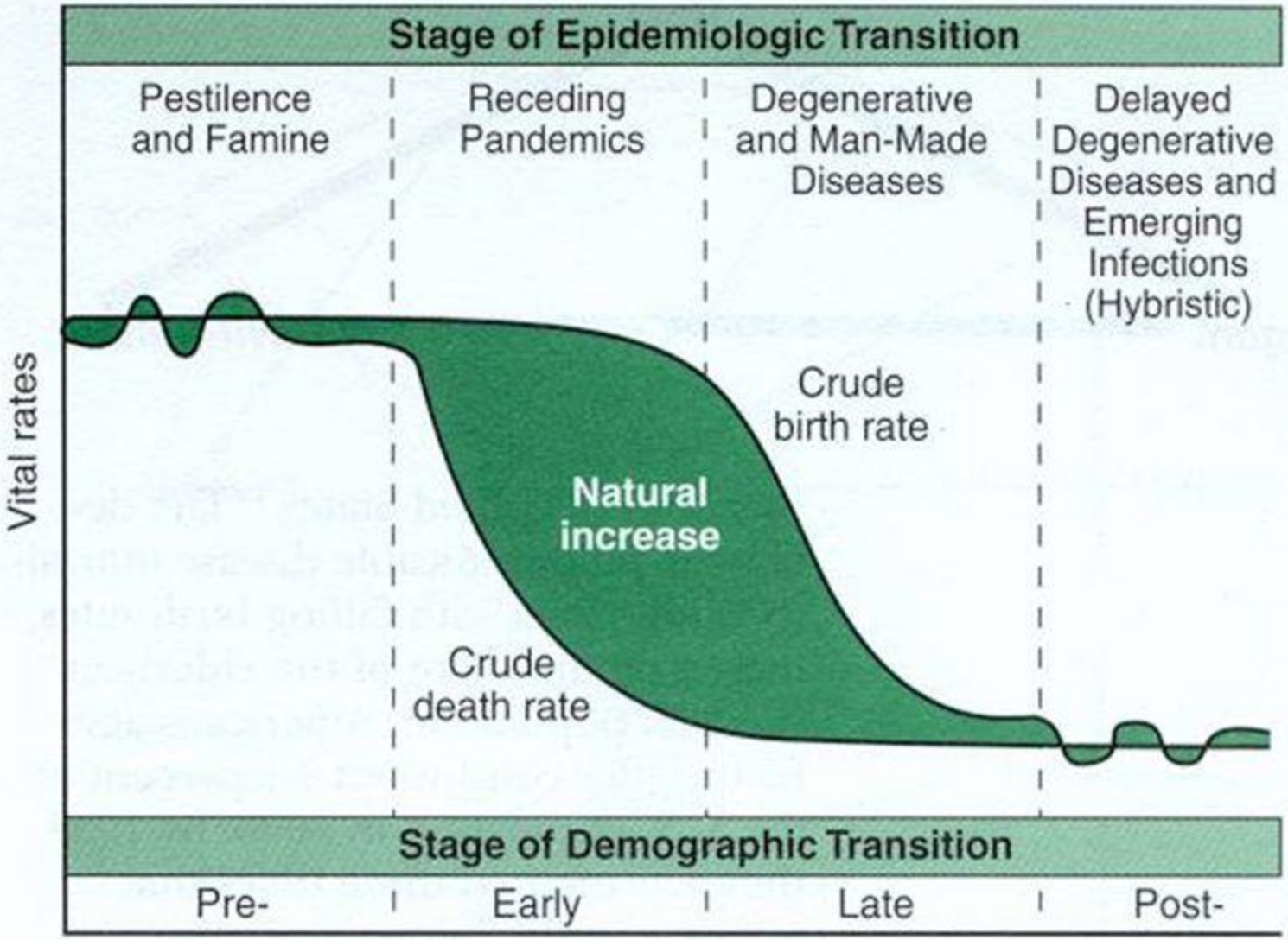
- Running over timescales that span decades or centuries
- Reduction in mortality is followed by a reduction in fertility
- Increased proportion of aging population
- Less malaria, diarrhoeal diseases, TB and HIV/AIDS
- More non-communicable diseases; cardiovascular diseases, cancer, COPD, road traffic accidents and diabetes mellitus
- Changes in burden of disease from communicable to non-communicable diseases.

THE EPIDEMIOLOGIC TRANSITION

- 1971, Abdel Omran
- The Epidemiologic transition theory describes the stages of development that are characterized by a shift in population growth, life expectancy and disease patterns.
- It describes the process by which the pattern of mortality and disease is transformed from one of high mortality among infants and children and episodic famine and epidemic affecting all age groups to one of degenerative and man-made diseases (such as those attributed to smoking) affecting principally the elderly.

Stages of Epidemiologic Transition

Demographic Transition Framework



Source: Ian R.H. Rockett. Population and Health: An Introduction to Epidemiology. Second edition. Population Reference Bureau 54(4); 1999: 9

Stage I: Pestilence and Famine

- Infectious and parasite diseases were principle causes of death along with accidents and attacks by animals and other humans.
- Most violent Stage I epidemic was the Black Plague(black death) probably transferred to humans by fleas from infected rats.
- 25 million Europeans died from 1347 to 1350.

Stage II: Receding Pandemics

- Improved sanitation, nutrition, and medicine during the Industrial Revolution reduced the spread of infectious diseases.
- Death rates did not improve immediately and universally during the early years of the Industrial Revolution.
- Poor people who crowded into Industrial Cities had high death rates due to cholera, due to acute diarrhea and vomiting that can kill within hours if left untreated.

Stage III: Degenerative Diseases

- Associated with the chronic diseases of aging
- Cardiovascular diseases and cancer
- Sub-Saharan Africa and South Asia have low incidences of cancer primarily because of low life expectancy.

Stage IV: Delayed Degenerative

- Life expectancy of older people is extended through medical advances.
- Cancer medicines, bypass surgery, better diet, reduced use of tobacco, and alcohol
- Consumption of non-nutritious food and sedentary behavior have resulted in an increase in obesity in this stage.

Possible – Stage V

- Infectious Diseases
- Reemergence of infectious and parasitic diseases; diseases thought to have been eradicated or controlled return, and new ones emerge

3 Possible Reasons for Stage V

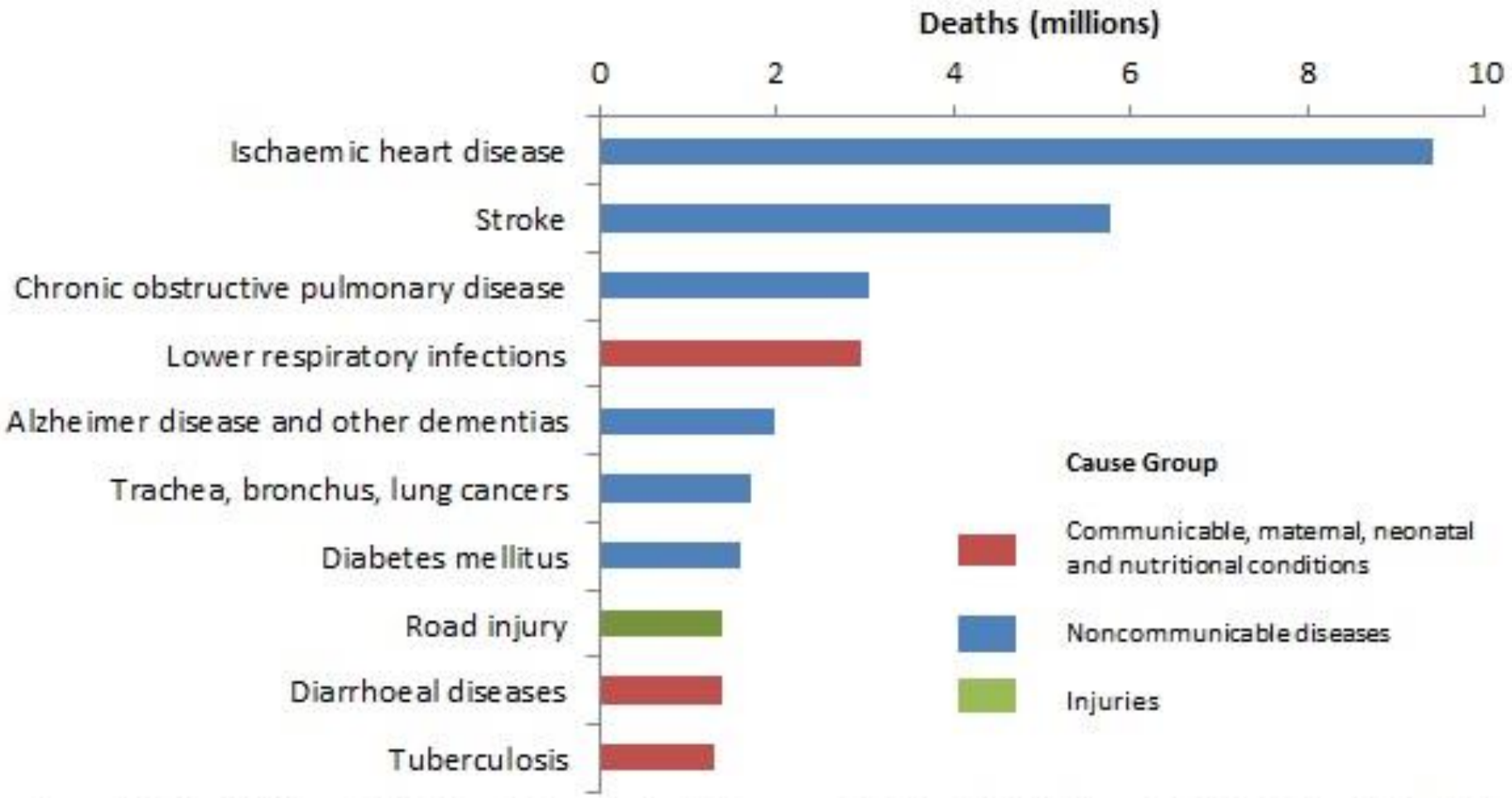
- Evolution – new strains due to drug resistance (malaria)
- Poverty- more infections due to unsanitary conditions, expensive (TB)
- Increased globalization – spread through relocation diffusion (H1N1/swine, severe acute respiratory syndrome (SARS).

THE EPIDEMIOLOGIC TRANSITION

This shift is caused by:

- The aging of the population, because non-communicable diseases affect older adults at the highest rates
- Improvements in medical care, which mean that children no longer die from malnutrition or from easily curable conditions such as diarrhea.
- public health interventions such as vaccinations and the provision of clean water and sanitation, which reduce the incidence of infectious diseases.
- This pattern can be observed across many countries, with wealthy countries further advanced along this transition.

Top 10 global causes of deaths, 2016



Source: Global Health Estimates 2016: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2016. Geneva, World Health Organization; 2018.

Epidemiologic Transition

Population health status measures

- Used to provide a full picture of which diseases, injuries and risk factors that contribute the most to poor health in a specific population. *"the burden of diseases and the risk factors that contribute to them".*

- To compare population health across communities and countries over time.

- To identify the most important health problems and whether they are getting better or worse over time

Population health status measures

- Governments need them to assess and set the national and local health priorities.
- Based on them decisions are made about investment in health systems and health interventions.
- Used as basis for health decision-making and for setting efficient preventive strategies.

Population health status measures

- For many years, population health was evaluated using mortality-based indicators only.
- Mortality-based indicators are useful, but they do not provide all the information necessary to assess the health of a population or to compare the effectiveness of interventions to protect or improve health.
- They do not take into consideration the effects of being ill and disabled for many years, before death or recovery.

Global Burden of Diseases Measures

- Used by the WHO and the World Bank
- Epidemiological Surveillance of the burden of diseases trends across borders and over time
- Provides basis for projections of future burden of diseases.
- Used as basis of information for decision-making on priorities in health research and health policy

Global Burden of Diseases Measures

- A quantitative overview of the burden of diseases world-wide
- Combines information about loss of quality of life with the traditional epidemiological information on mortality
- All health outcomes are expressed in DALYs

Disability-adjusted life years (DALYs) are years of healthy life lost to premature death and disability. This figure shows that communicable diseases declined between 1990 and 2015.

Health-Adjusted Life Years (HALYs)

- **Health-Adjusted Life Years (HALYs)**
- Summary measures of population health used in burden of disease estimates.
- They combine the effects of disability or disease (morbidity) and death (mortality) simultaneously.
- HALYs, an umbrella term for a number of such summary measures, allow for comparisons to be made across illnesses, interventions, and populations .
- The data are normally presented by age, sex, and region.

Health-Adjusted Life Years (HALYs)

- To calculate the HALYs of a disease, three general steps are required. As Gold et al., describe, researchers must:

1. Describe the associated state of health ("health state") or disease conditions;
2. Develop numerical values or weights for the health state or condition;
3. Combine the numerical values of each health state with estimates of life expectancy.

Health-Adjusted Life Years (HALYs)

- The morbidity components of HALYs are referred to as **Health-Related Quality of Life (HRQL)** and is represented on a scale of 0 to 1.
- Two common measures of HALYs,
  - **Quality-Adjusted Life Years (QALYs)** and
  - **Disability-Adjusted Life Years (DALYs)**,

  As will be seen, QALY and DALY have different purposes and use different approaches to calculate HRQL associated with disease conditions or good health.

QALYs

QALYs

- Quality-adjusted life years are usually used to assess clinical interventions.
- The goal is to maximize the “good” of quality of life.
- QALYs use utility weights (0 = death and 1 = perfect health)
- QALYs can measure both the effectiveness and the cost-effectiveness of an intervention.

QALYs

- For example, QALYs can compare an intervention that can help prolong life but has serious side effects (such as permanent disability caused by radiation or chemotherapy for cancer), with an intervention that improves quality of life without prolonging it (such a palliative pain management).
- The measure can give an idea of how many extra months or years of life of reasonable quality of health a person might gain with each intervention.
- QALYs are calculated by multiplying the number of years of life added, by the HRQL.
- **QALYs = additional number years of life x HRQL**

Example

- If someone has a chronic disease and is expected to live for five years with his present treatment but whose condition is reducing his quality of life to half that of someone in full health, he would gain 5 x 0.5 = 2.5 QALYs.
- With a new medicine on the market that relieves his symptoms and improves his quality of life to three quarters that of someone in full health, though without increasing his life expectancy, he would gain 5 x 0.75 = 3.75

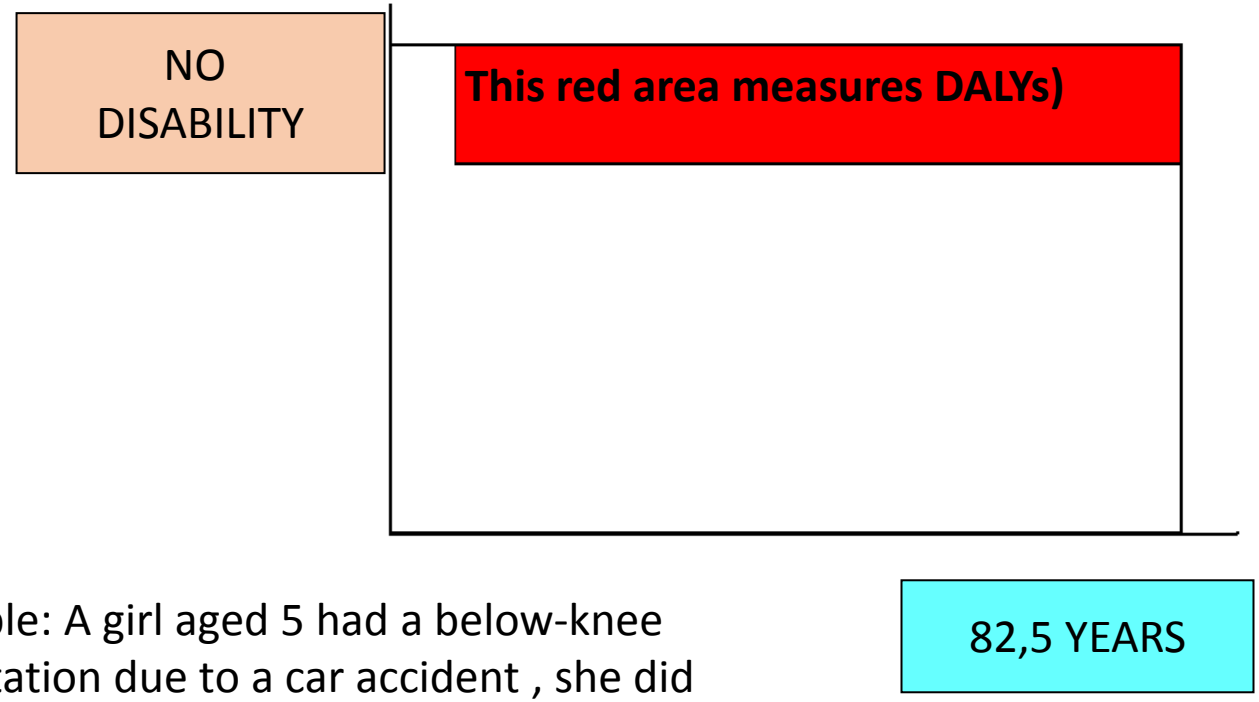
What is DALYs?

- DALYs = Disability Adjusted Life Years
- A common measurement unit for morbidity and mortality
- Facilitates comparisons of health outcomes
- A DALY is a health outcome measure with two main components:
  - Quality of life reduced due to a disability
  - Lifetime lost due to premature mortality.

DALYs are used for:

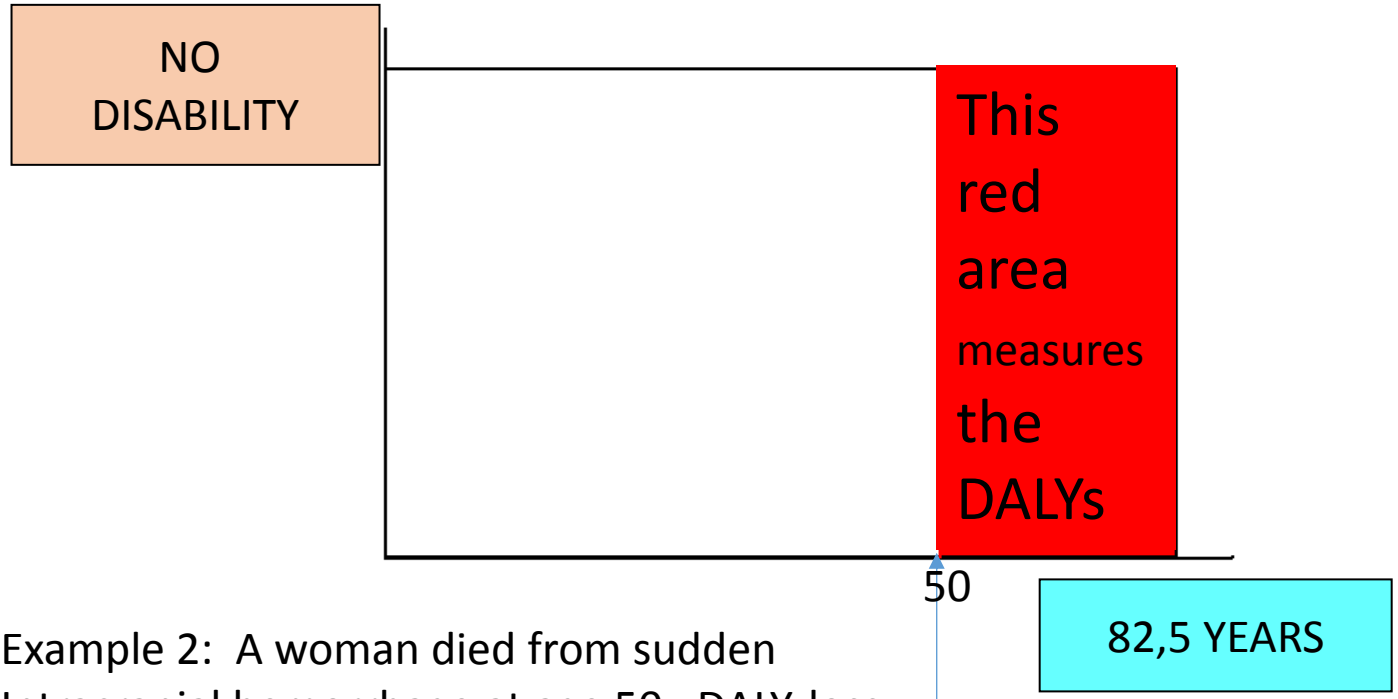
- For epidemiological surveillance of the total disease burden (number of DALYs)
- To measure cost- effectiveness of interventions (cost per avoided DALY)
- To decide what should be included in a country's 'core services' (the package of essential health care services). Within a fixed budget. (Based on the cost per avoided DALY) .
- DALYs provide information for policy makers concerned with national priority setting and international health comparisons

DALYs due to living with disability



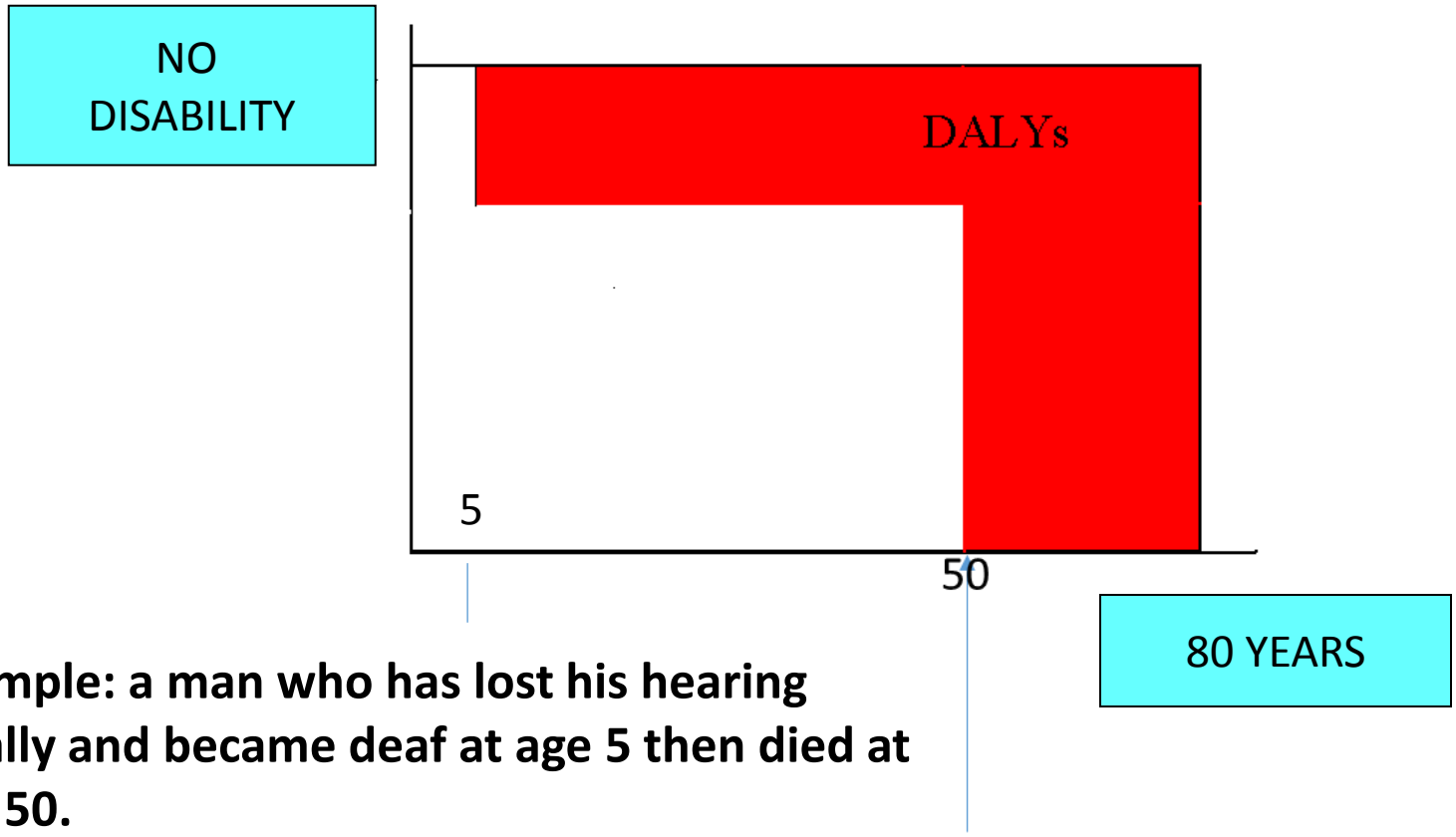
Example: A girl aged 5 had a below-knee amputation due to a car accident , she did was partly disabled but did not die, her DALY loss can be calculated by multiplying 77.5 years adjusted by a disability weight. If this weight is, say, 0.3, her loss is 0.3 x 77,5 = 23.3.

DALYs due to early death



Example 2: A woman died from sudden Intracranial hemorrhage at age 50 . DALY-loss 32.5 years which is the red area in this figure. No adjustment is made for disability because the patient died

DALYs due to disability and premature death combined.



Example: a man who has lost his hearing totally and became deaf at age 5 then died at age 50.
(Disability weight of deafness is set at 0.33)

Calculation of DALYs

- **Number of healthy life years × the disability weight of full health (0) + life years with disability (50) × disability weight for deafness (0,33) + life years lost (30) × the weighting of death (1)**

  (5 × 0) + (45 × 0,33) + (30 × 1) = 44.85 DALYs

DALYs and QALYs

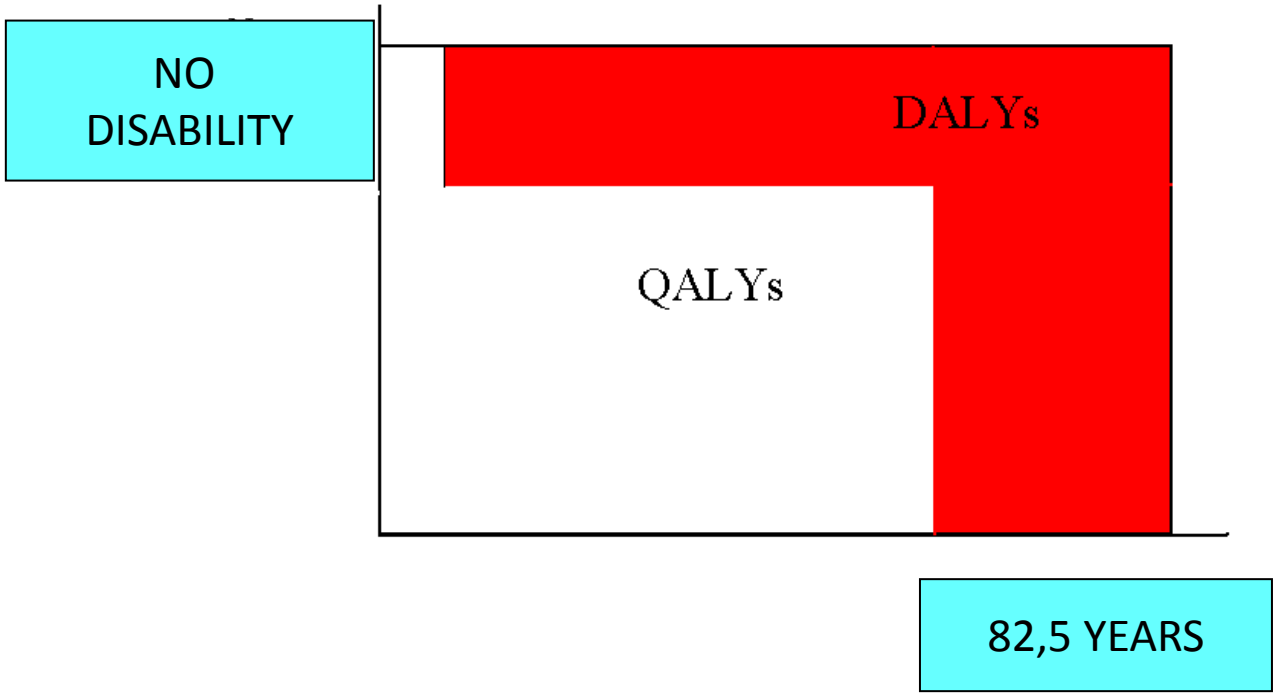
- DALY is a modification of QALY (Quality Adjusted Life Years).
- Both concepts combine information about length of life and quality of life.
- A DALY is a negative QALY.

Complementarity between QALYs and DALYs

- QALYs are years of healthy life lived
- DALYs are years of healthy life lost
- QALYs represent a gain and should be maximised.
- DALYs represent a loss and should be minimised.
- In DALYs, the years are disability weighted on a scale from zero, which represents perfect health (no disability), to one, which indicates death.
- In the QALYs, the scale goes the opposite way: A quality weighting (sometimes called “utility”) of 1 indicates perfect health, whereas 0 indicates no quality of life, and is synonymous to death.

Relation between QALYs and DALYs

DALYs = healthy years lost
QALYs = healthy years gained



How are disability adjustments made?

- The methods used to assign a disability weightings to life years is a critical part of the DALYs.
- Diagnostic groups must be chosen and defined and described.
- The health states are assigned a disability weight to indicate the relative severity of each health state.

Discounting in DALYs

- In addition to adjusting the value of life years with disability weights and selecting a particular life expectancy, in the Global Burden of Disease DALYs calculation: the value of a life year is modified by
- Discounting
  - the value of a life year now is set higher than the value of future life years
- Age weighting
  - life years of children and old people are counted less

DALYs is criticised

- **For discriminating**
  - women
  - The disabled
  - Young
  - Elderly
  - Future generations (future health benefits)