Population Health Metrics

Consuelo Quispe MD. | Social Epidemiology | RECETOX

Objectives

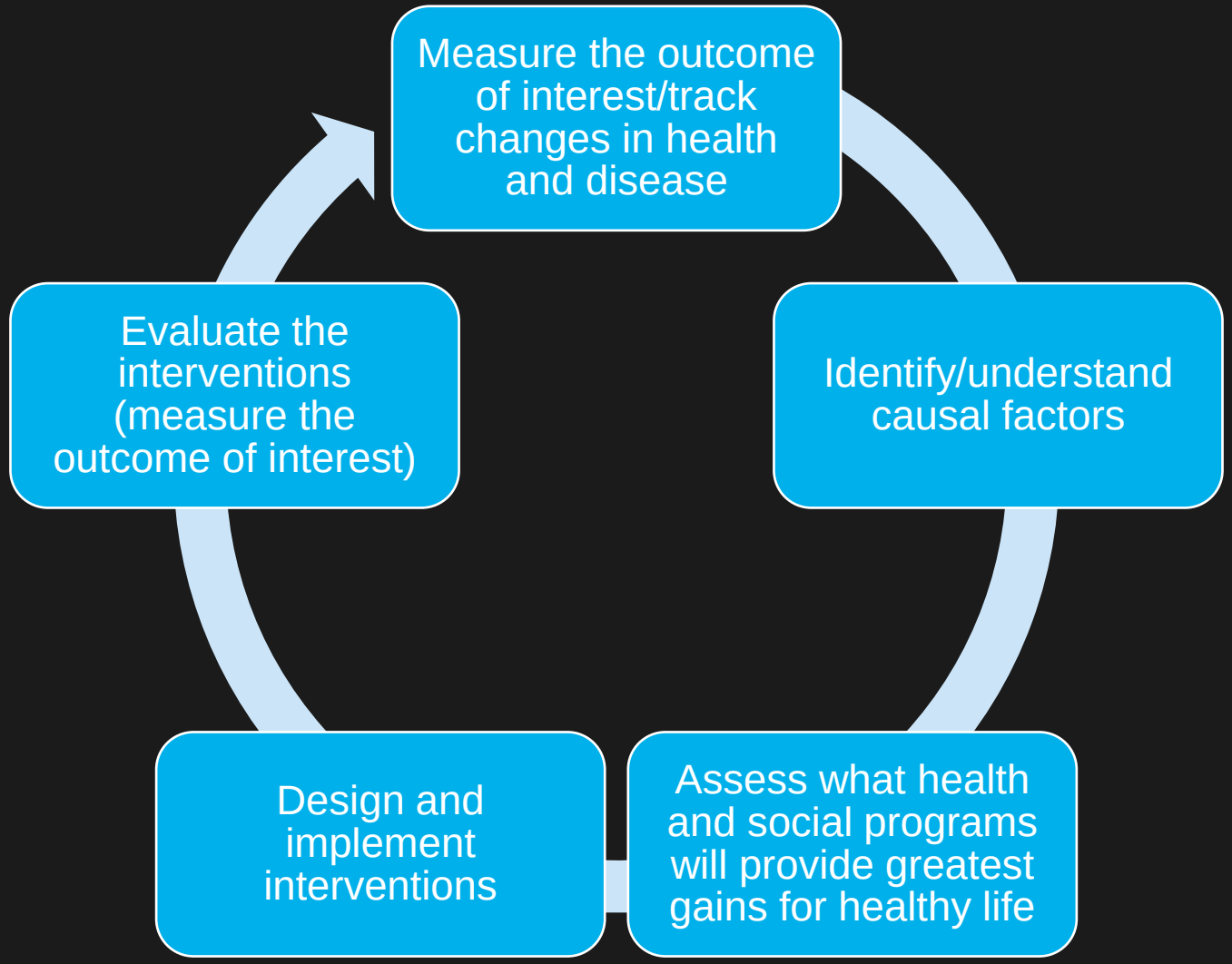
By the end of the session, students should understand:

- Purpose of different health indicators
- Main health indicators used in public/population health
- Selected features and findings of the Global Burden of Disease (GBD) program
  - Health outcomes used in the GBD
  - Conditions accounting for most ill health burden
  - Risk factors responsible for ill health
- Next class
  - Absolute vs. relative inequalities of health

What are the steps to improve health?

Think about one health issue and how to address it.

Steps to improve health



Step 1: Measure the outcome

- Find appropriate indicators to measure, estimate or quantify:
  - health and disease in population(s)
  - risk factors/determinants
  - attribution of ill health to risk factors/determinants
- Sometimes “big brush” picture
- Largely based on routinely available data
- Often combining data from various sources
- Crucial for policy decisions, priority setting, design of interventions, evaluation of interventions

“Conventional” measures

- Prevalence of a disease/exposure
- Incidence of a disease

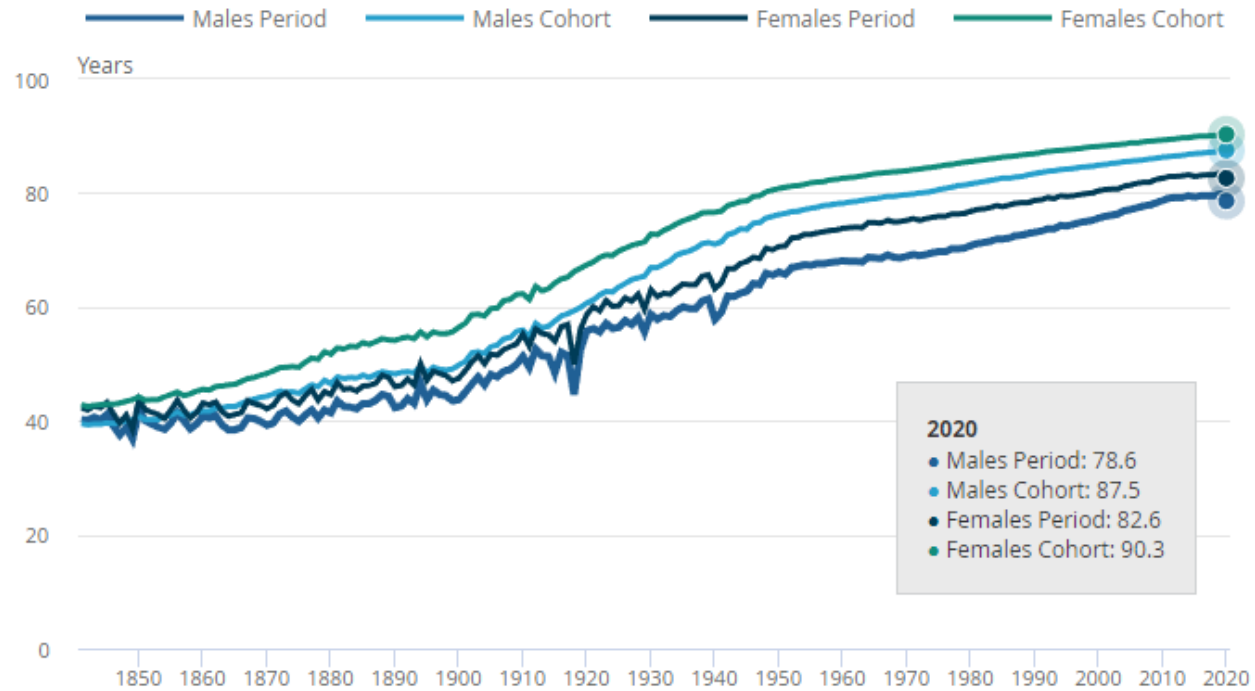
- Mortality
  - all causes vs. cause-specific rates
  - all ages vs. age-specific rates

- Life expectancy
  - At birth
  - At a specific age

Life expectancy: assumptions

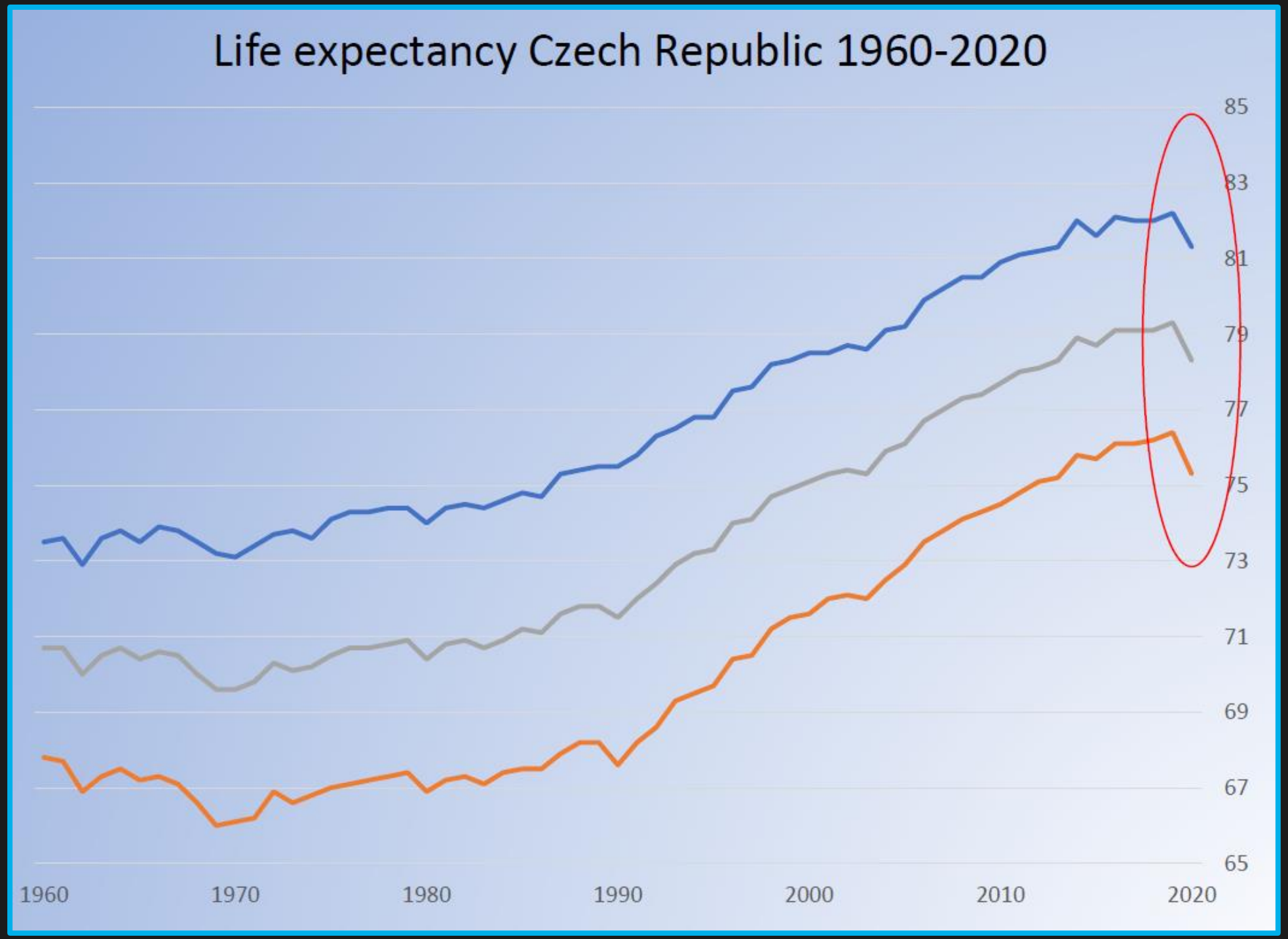
- ‘Period life tables’ unrealistically assume mortality will stay the same in the future.
- Life expectancy has been growing at around 3 months a year for decades, corresponding to the annual risk of death reducing by about 2% per year.
- ‘cohort life’ makes various projections about whether these trends will continue in the future.

Figure 1: Period and cohort life expectancy at birth, males and females, England and Wales, 1841 to 2020

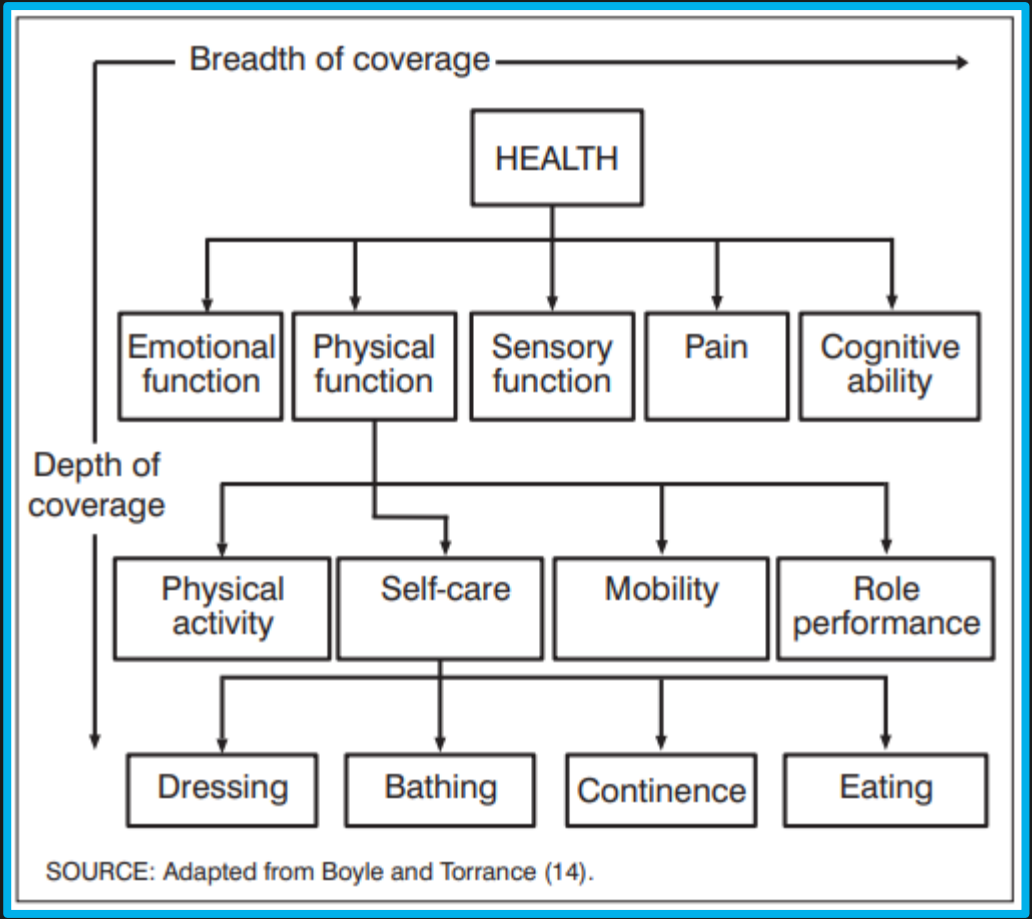


https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/methodologies/periodandcohortlifeexpectancyexplained#difference-between-period-and-cohort-life-expectancies

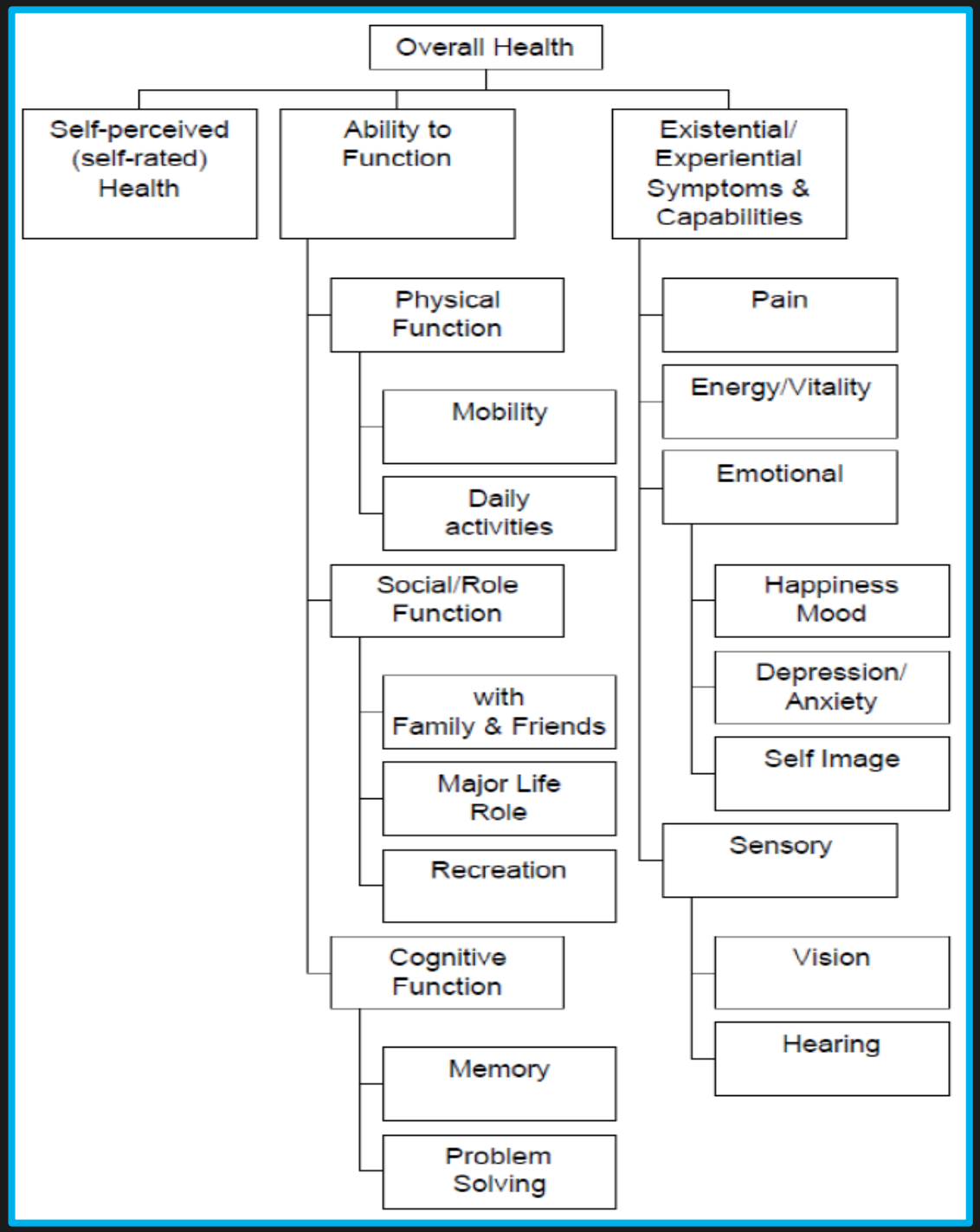
https://webarchive.nationalarchives.gov.uk/ukgwa/20160105221532/http://www.ons.gov.uk/ons/rel/lifetables/historic-and-projected-data-from-the-period-and-cohort-life-tables/2012-based/stb-2012-based.html


Life expectancy Czech Republic 1960-2020
85
83
81
79
77
75
73
71
69
67
65
1960
1970
1980
1990
2000
2010
2020

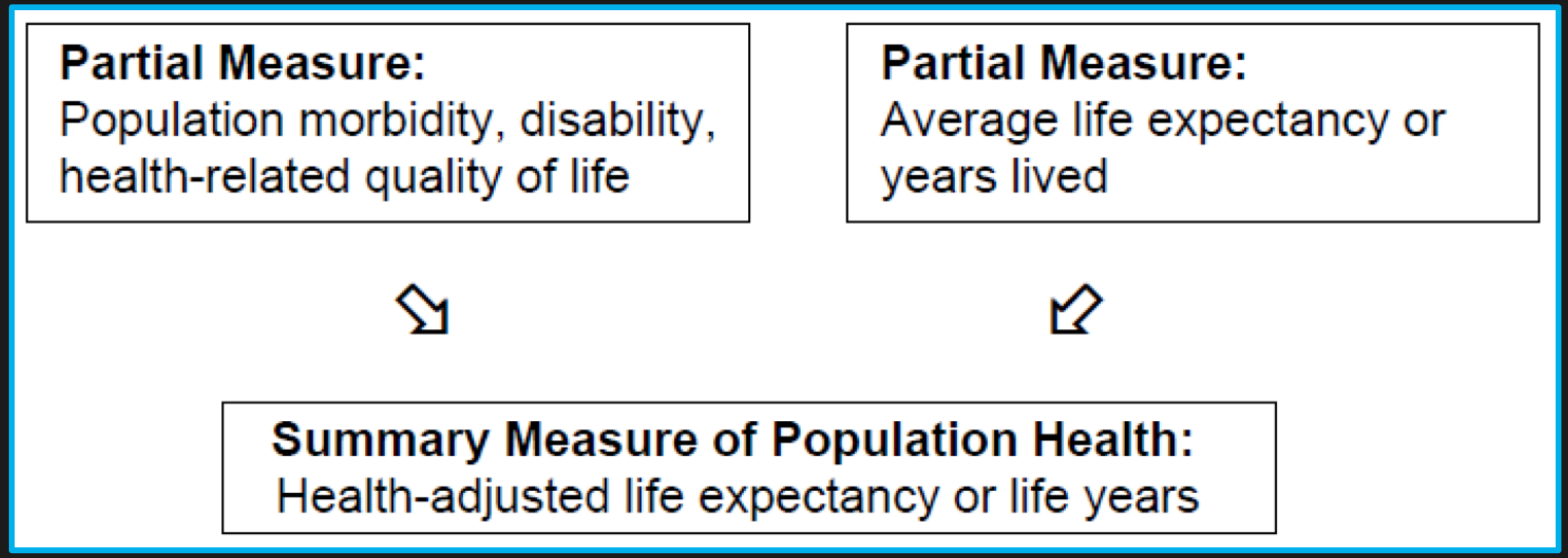
From partial measures to summary measures



Molla MT, Wagener DK, Madans JH. Summary measures of population health: methods for calculating healthy life expectancy. Healthy People 2010 Stat Notes. 2001 Aug;(21):1-11. doi: 10.1037/e583762012-001. PMID: 11676467.

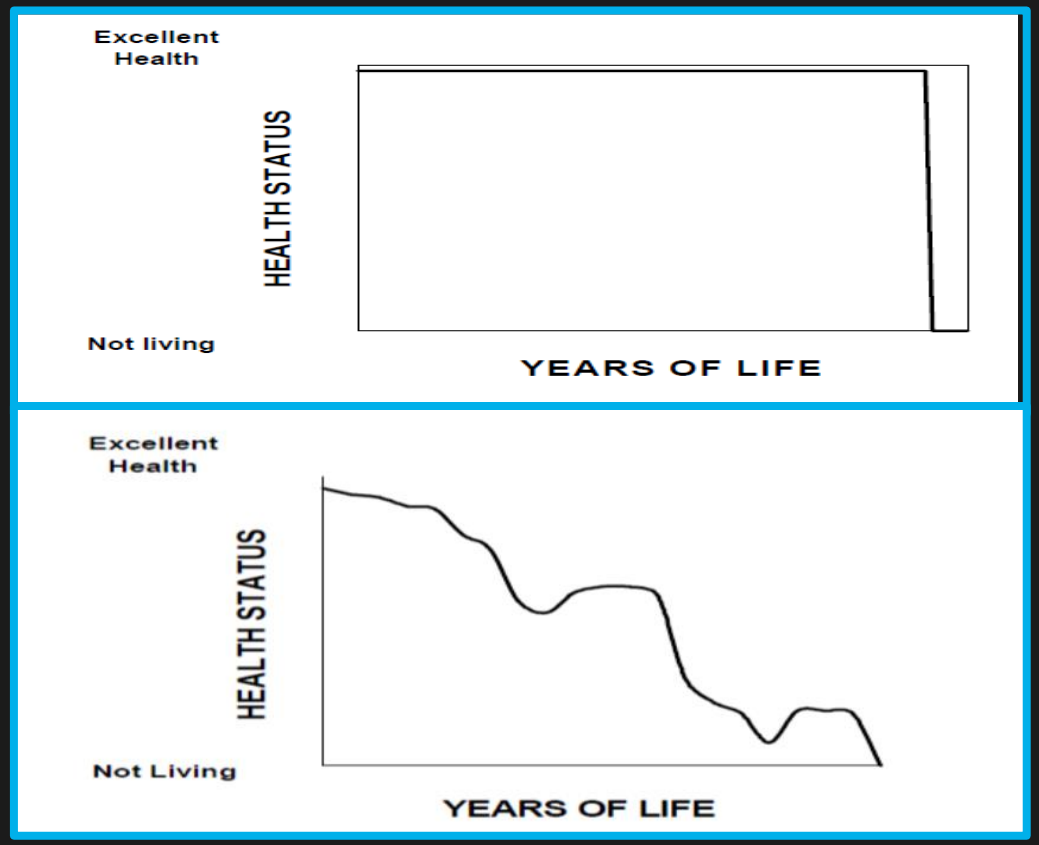


From partial measures to summary measures



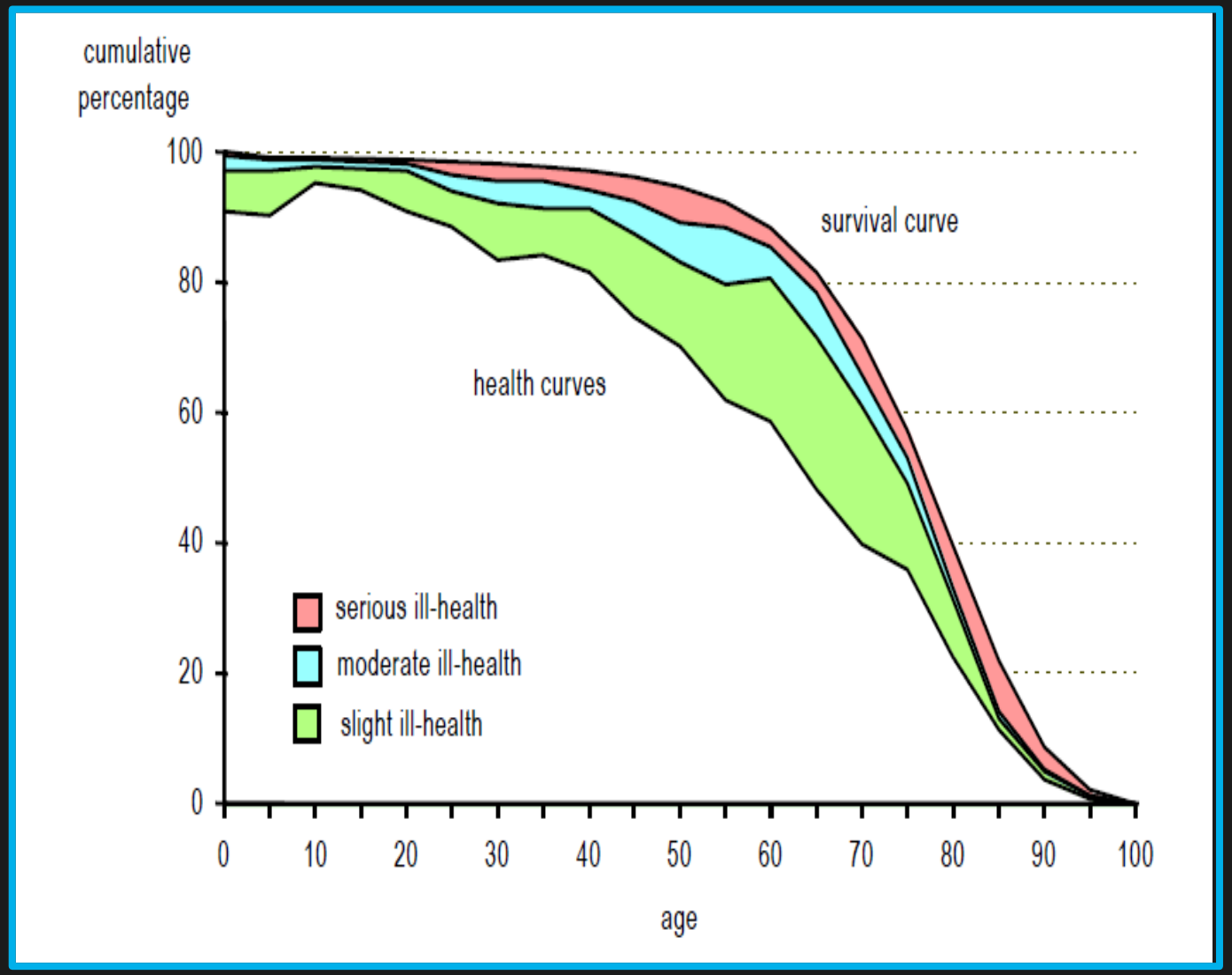
From Field & Gold, 1998

Life paths



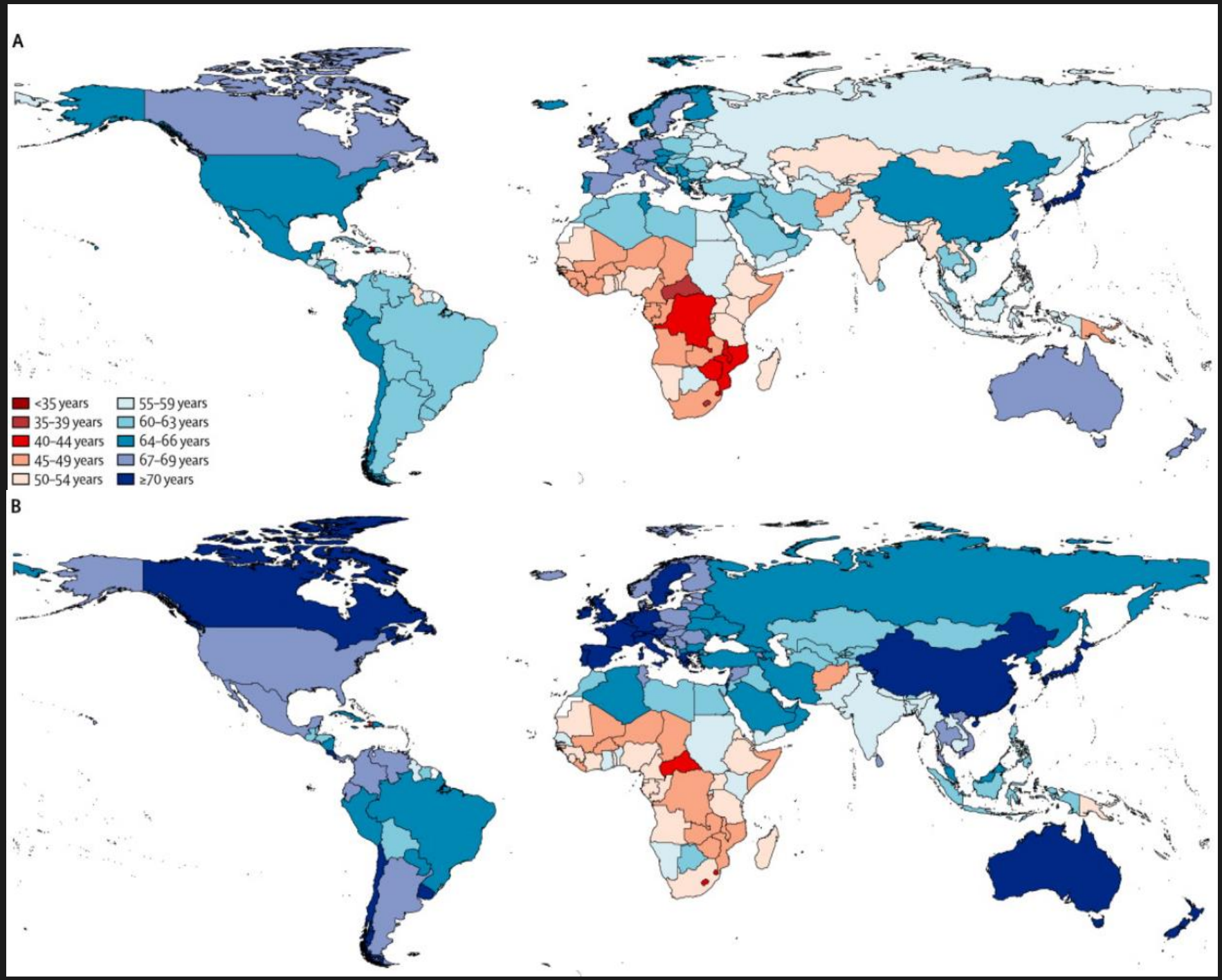
Morbidity compression (rectangularisation)

Compression of morbidity hypothesis. Fries, 1998



Healthy life expectancy (HALE)

- Healthy life expectancy or health-adjusted life expectancy (HALE) measures the number of years that a person at a given age can expect to live in good health, accounting for mortality and disability.
- Equals to the average number of years a newborn can expect to live “full”. In other words, not hampered by disabling illnesses or injuries
- Summarizes mortality and nonfatal outcomes in a single measure of average population health
- Can compare health between countries or measure changes over time
- Can inform policy questions dependent on how morbidity changes as mortality decrease.



Healthy life expectancy at birth by country, 2010

The Lancet 2012 380, 2144 2162 A

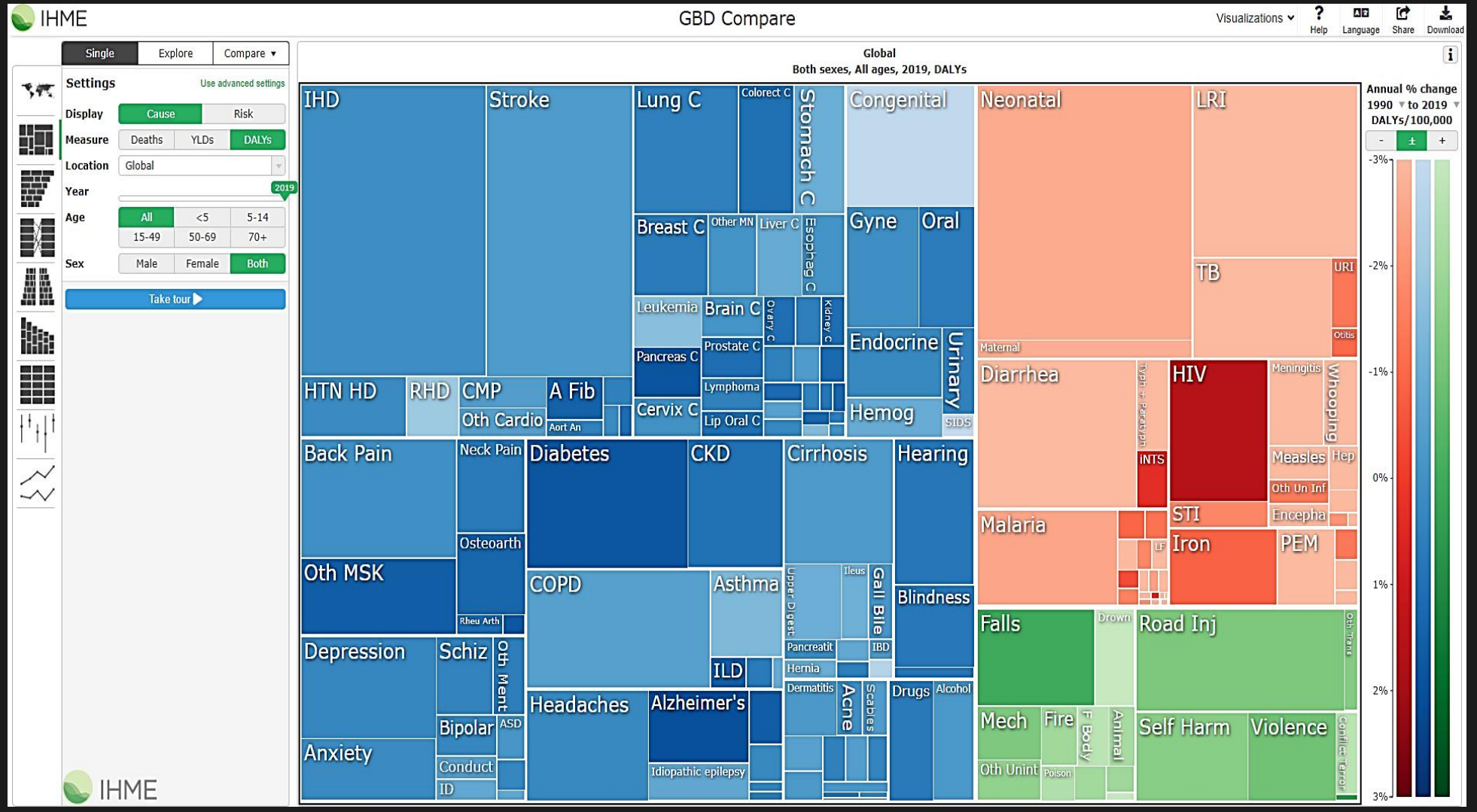
Male healthy life expectancy (A) and female healthy life expectancy (B).

Global Burden of Diseases (GBD)

- “Global descriptive epidemiology”
- Systematic, scientific effort to quantify the comparative magnitude of health loss due to diseases, injuries, and risk factors by:
  - age
  - sex
  - geographies
  - specific points in time
- Compare the effects of different diseases that kill people prematurely and cause ill health and disability.
- GBD was established by WHO, WB, and Harvard in 1996, currently led by the Institute for Health Metrics and Evaluation (IHME), University of Washington.
- https://vizhub.healthdata.org/gbd-compare/

GBD metrics

- All cause mortality
- Deaths by cause
- Years of life lost (YLLs)
- Years lived with disability (YLDs)
- Disability-adjusted life years (DALYs) for
- Comprehensive list (2013)
- 291 causes of diseases and injuries
- 67 risk factors



The Disability-Adjusted Life Years (DALY)

- A summary measure that combines time lost through premature death and time lived in states of less than optimal health, loosely referred to as “disability”.
- One DALY can be thought of as one year of ‘healthy’ life lost.
- Combines the years of life lost through:
  - premature death
  - years of healthy life lost through disability.
- DALYs lost = Years of healthy life lost.
- If everybody in a population lived to 80 completely healthy, then there would be zero DALYs

YLL and YLD composition of total DALYs by region, 2010

Source: The Global Burden of Disease: Generating Evidence, Guiding Policy (GBD 2010)

Calculating DALYs

1. Classify all disease and conditions into 107 categories in 3 groups and assign into 7 disability classes weighted from 0 (perfect health) to 1 (death).
2. Assign all deaths to a category by age, sex and region
3. Calculate years of life lost per death
4. Estimate all cases of disability by age, sex , region, severity (disability class) and duration (years of healthy life lost) until remission or death
5. Combine all deaths and disability losses by cause, age, sex and region
6. Allow a discount rate of 3% so future years of healthy life are valued at progressively lower levels
7. Weight years of life lost at different relative values less for children and aged, more for adults (maximum value at age 25)
8. Sum all DALYS to obtain the Global Burden of Disease

Examples of mean disability weights (2004)

- AIDS 0.505
- Infertility 0.180
- TB 0.272
- Blindness 0.600
- Diabetes 0.015
- Depression 0.399
- Alzheimer's 0.666
- Angina 0.141
- Deafness 0.234

https://ghdx.healthdata.org/gbd-2019

1	GBD 2019 sequelae, health states, health state lay descriptions, and disability weights			
2	**Sequela**	**Health state name**	**Health state lay description**	**Disability Weight**
3	HIV/AIDS - Drug-susceptible Tuberculosis without anemia	Tuberculosis, HIV infected	has a persistent cough and fever, shortness of breath, night sweats, weakness and fatigue and severe weight loss.	0.408 (0.274-0.549)
4	HIV/AIDS - Drug-susceptible Tuberculosis with mild anemia	Tuberculosis, HIV infected and anemia, mild	(combined DW)	0.411 (0.278-0.551)
5	HIV/AIDS - Drug-susceptible Tuberculosis with moderate anemia	Tuberculosis, HIV infected and anemia, moderate	(combined DW)	0.439 (0.307-0.577)
6	HIV/AIDS - Drug-susceptible Tuberculosis with severe anemia	Tuberculosis, HIV infected and anemia, severe	(combined DW)	0.495 (0.353-0.64)
7	HIV/AIDS - Multidrug-resistant Tuberculosis without extensive drug resistance without anemia	Tuberculosis, HIV infected	has a persistent cough and fever, shortness of breath, night sweats, weakness and fatigue and severe weight loss.	0.408 (0.274-0.549)
8	HIV/AIDS - Multidrug-resistant Tuberculosis without extensive drug resistance with mild anemia	Tuberculosis, HIV infected and anemia, mild	(combined DW)	0.411 (0.278-0.551)
9	HIV/AIDS - Multidrug-resistant Tuberculosis without extensive drug resistance with moderate anemia	Tuberculosis, HIV infected and anemia, moderate	(combined DW)	0.439 (0.307-0.577)
10	HIV/AIDS - Multidrug-resistant Tuberculosis without extensive drug resistance with severe anemia	Tuberculosis, HIV infected and anemia, severe	(combined DW)	0.495 (0.353-0.64)
11	HIV/AIDS - Extensively drug-resistant Tuberculosis without anemia	Tuberculosis, HIV infected	has a persistent cough and fever, shortness of breath, night sweats, weakness and fatigue and severe weight loss.	0.408 (0.274-0.549)
12	HIV/AIDS - Extensively drug-resistant Tuberculosis with mild anemia	Tuberculosis, HIV infected and anemia, mild	(combined DW)	0.411 (0.278-0.551)
13	HIV/AIDS - Extensively drug-resistant Tuberculosis with moderate anemia	Tuberculosis, HIV infected and anemia, moderate	(combined DW)	0.439 (0.307-0.577)
14	HIV/AIDS - Extensively drug-resistant Tuberculosis with severe anemia	Tuberculosis, HIV infected and anemia, severe	(combined DW)	0.495 (0.353-0.64)
15	Symptomatic HIV without anemia	HIV cases, symptomatic, pre-AIDS	has weight loss, fatigue, and frequent infections.	0.274 (0.184-0.377)
16	AIDS without anemia	AIDS cases, not receiving ARV treatment	has severe weight loss, weakness, fatigue, cough and fever, and frequent infections, skin rashes and diarrhea.	0.582 (0.406-0.743)
17	Early HIV without anemia	Generic uncomplicated disease: anxiety about diagnosis	has a disease diagnosis that causes some worry but minimal interference with daily activities.	0.012 (0.006-0.023)
18	Early HIV with mild anemia	Anemia, mild; Generic uncomplicated disease anxiety		0.016 (0.008-0.031)
19	Early HIV with moderate anemia	Anemia, moderate; Generic uncomplicated disease anxiety		0.063 (0.04-0.095)
20	Early HIV with severe anemia	Anemia, severe; Generic uncomplicated disease anxiety		0.159 (0.109-0.22)
21	Symptomatic HIV with mild anemia	HIV cases, symptomatic, pre-AIDS and anemia, mild	(combined DW)	0.277 (0.189-0.379)
22	Symptomatic HIV with moderate anemia	HIV cases, symptomatic, pre-AIDS and anemia, moderate	(combined DW)	0.312 (0.217-0.418)
23	Symptomatic HIV with severe anemia	HIV cases, symptomatic, pre-AIDS and anemia, severe	(combined DW)	0.381 (0.269-0.505)

Trends in DALYs from 1990 to 2015 by cause

The Lancet 2016 388, 1603 1658

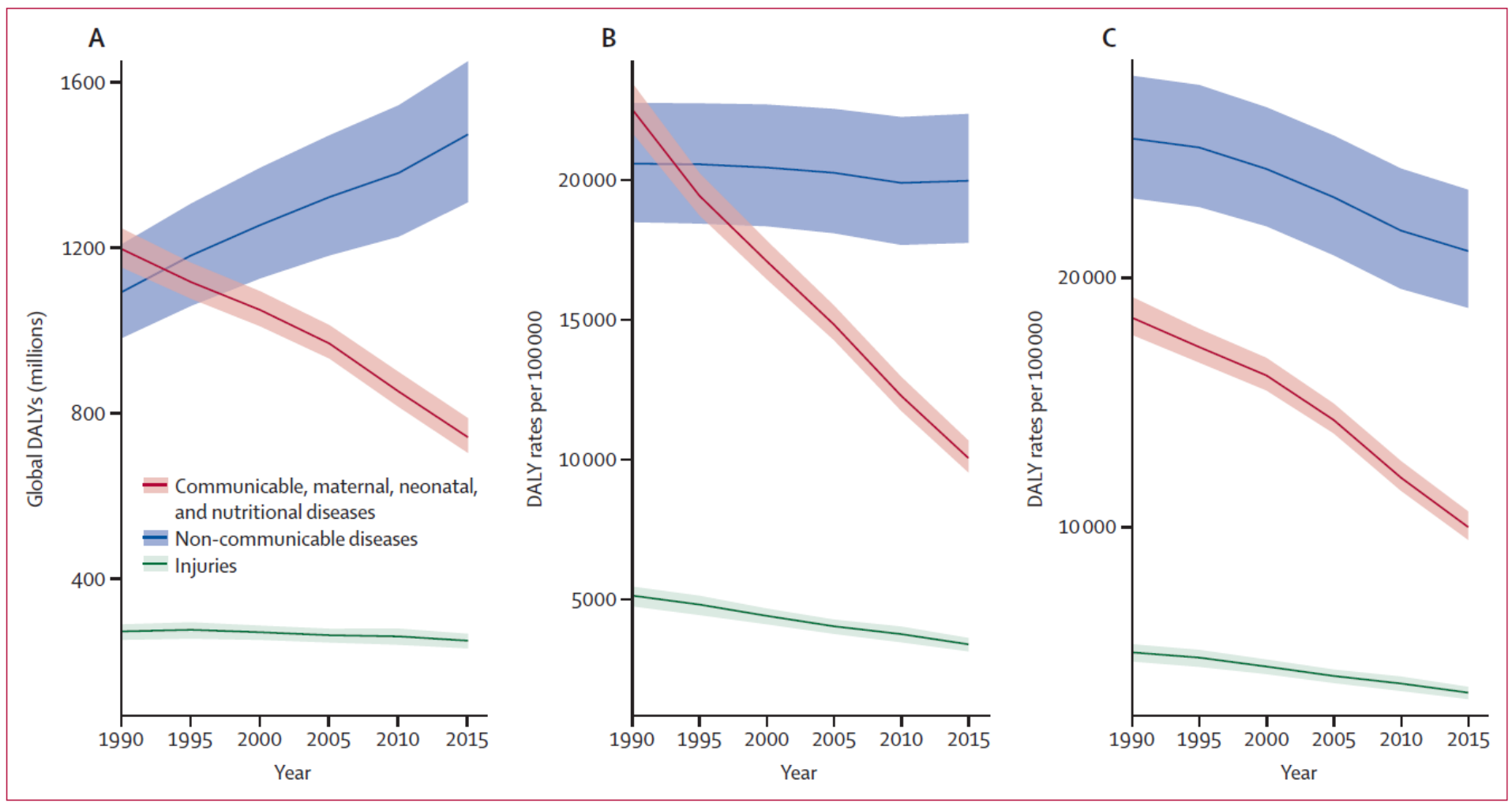
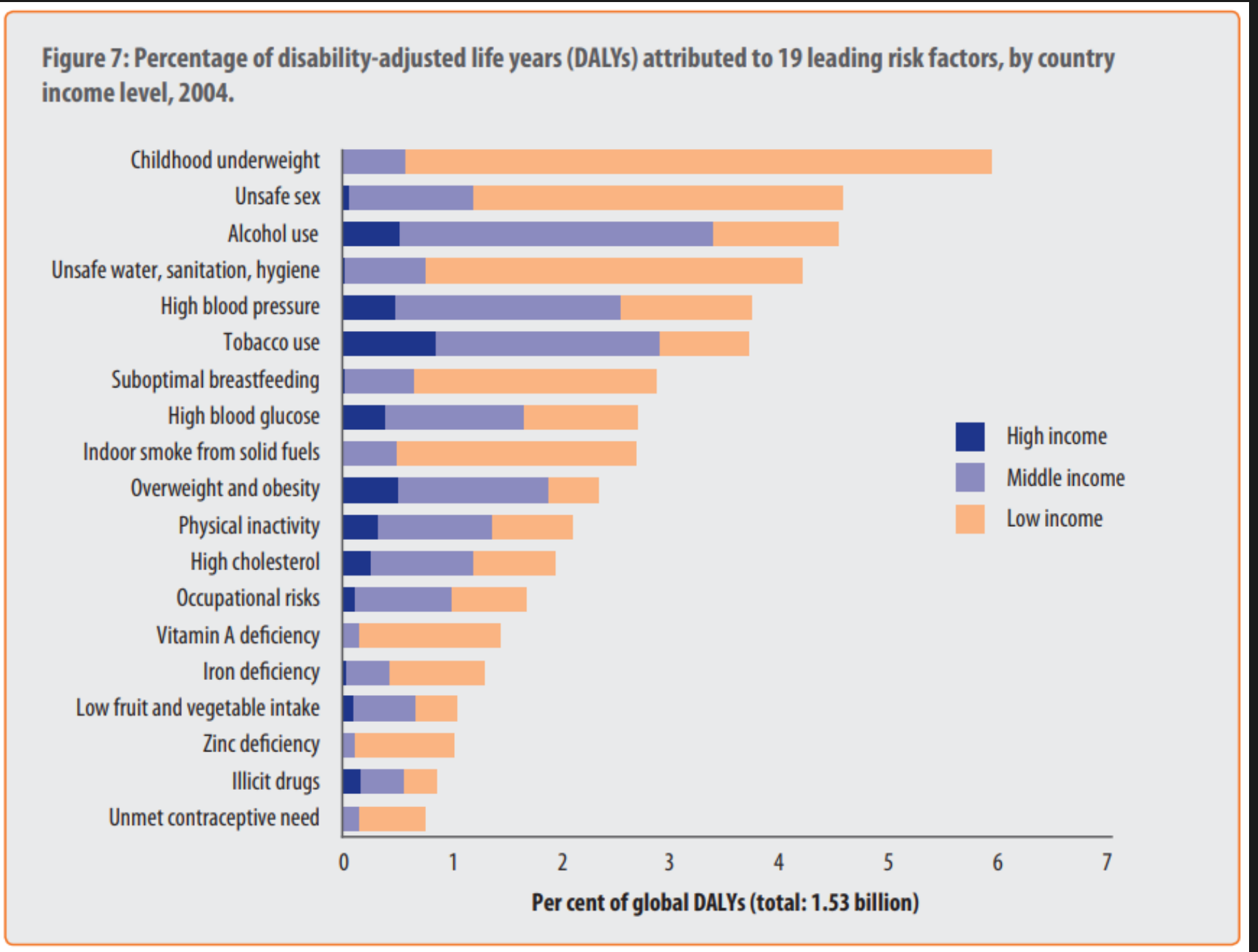


Figure 1: Trends from 1990 to 2015, by GBD Level 1 cause, in global DALYs (A), crude DALY rates (B), and age-standardised DALY rates (C)

Incorporating risk factors

- Comparative risk assessment (CRA) approach, developed by Murray and Lopez (Epidemiol ., 1999)
- Conceptual framework for population risk assessment across risks and over time.
- Evaluates how much of the burden of disease observed in a given year can be attributed to past exposure to a risk factor.
- Attributable burden is estimated by comparing observed health outcomes to those that would have been observed had a counterfactual level of exposure occurred in the past.
- Different risks lead to different health outcomes: separate assessments undertaken for specific risk outcome pairs.

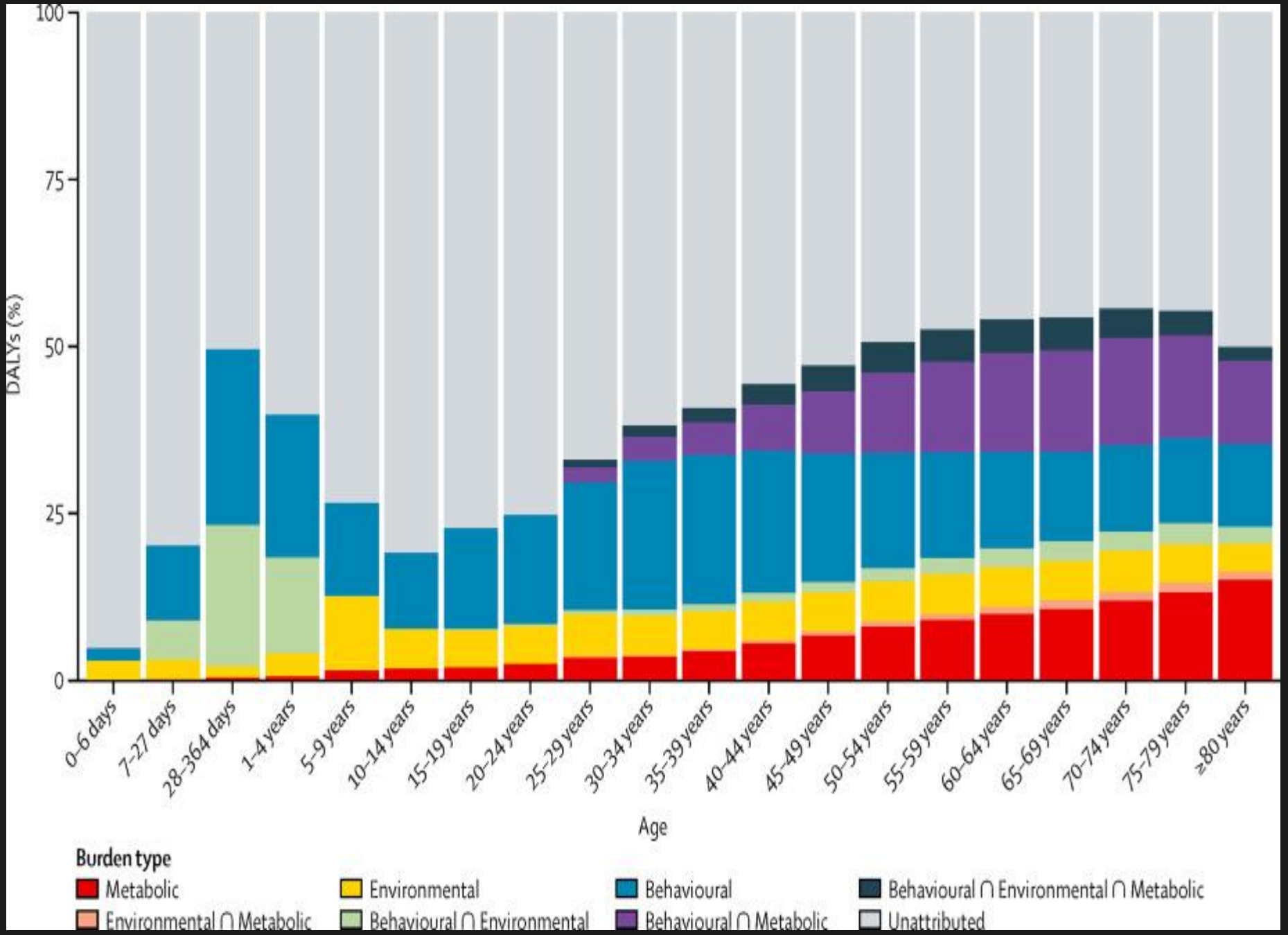


Global health risks: mortality and burden of disease attributable to selected major risks.

https://apps.who.int/iris/bitstream/handle/10665/44203/9789241563871_eng.pdf?sequence=1&isAllowed=y

The proportion of global all-cause DALYs attributable to behavioral, environmental and occupational, and metabolic risk factors and their overlaps, by age for both sexes combined in 2013.

https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(15)00128-2/fulltext#figures



Summary

Different health indicators have different purpose.

Conventional indicators remain primary sources of data.

GBD metrics extremely influential.

DALY widely used but complex and sometimes difficult to interpret.