# Population health metrics

# 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) programme in terms of:
  - Health outcomes used in the GBD
  - Conditions accounting for most ill health burden
  - Risk factors responsible for ill health

# Steps to improve health

- Measure the outcome of interest / track changes in health and disease

- Identify / understand causal factors

- Assess what health and social programmes will provide greatest gains for healthy life

- Design and implement interventions

- Evaluate the interventions (measure the outcome of interest)

# Population health metrics

- Indicators used 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 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 at about 2% per year.

- 'cohort life tables' make various projections about whether these trends will continue in the future:
    - the 'central projection' says girls born now have a life expectancy of 94, with a median and mode of around 100
    - men have a life expectancy of 91, with a median and mode of around 96.
    - Under the 'high' projections, with the possibly implausible assumption that the increases continue at the same rate in the future, children born today will on average live more than 100 years.

# Summary measures

# Building a summary measure from partial measures of health
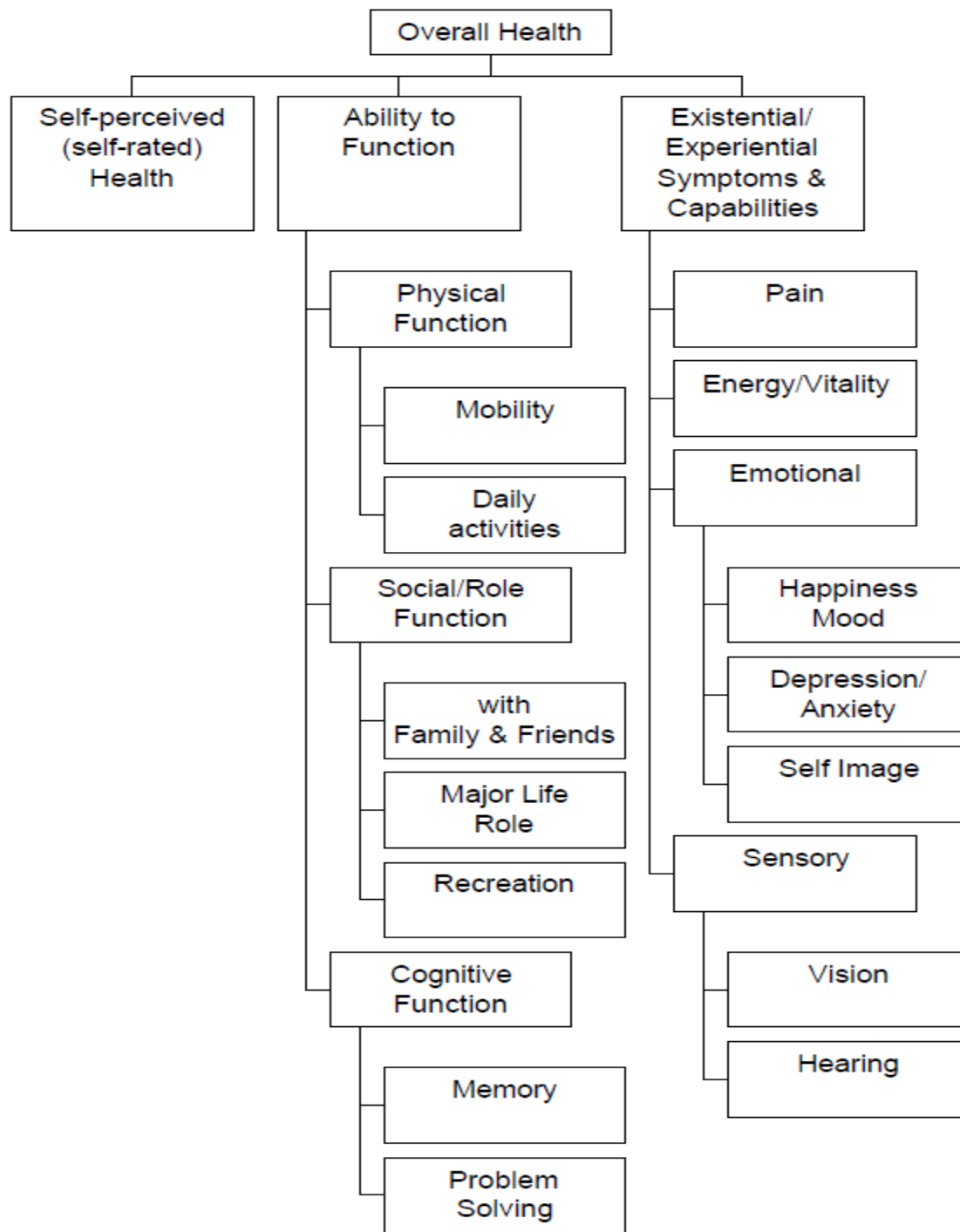
**Partial Measure:**
Population morbidity, disability, health-related quality of life

**Partial Measure:**
Average life expectancy or years lived

**Summary Measure of Population Health:**
Health-adjusted life expectancy or life years

From Field & Gold, 1998

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                              ┌──────────────────┐
                              │  Overall Health  │
                              └──────────────────┘
         ┌───────────────────────────┼───────────────────────────────┐
┌──────────────────┐      ┌──────────────────┐          ┌──────────────────────┐
│  Self-perceived  │      │   Ability to     │          │     Existential/     │
│  (self-rated)    │      │    Function      │          │    Experiential      │
│     Health       │      │                  │          │    Symptoms &        │
└──────────────────┘      └──────────────────┘          │    Capabilities      │
                                                         └──────────────────────┘
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- Ability to Function
  - Physical Function
    - Mobility
    - Daily activities
  - Social/Role Function
    - with Family & Friends
    - Major Life Role
    - Recreation
  - Cognitive Function
    - Memory
    - Problem Solving

- Existential/Experiential Symptoms & Capabilities
  - Pain
  - Energy/Vitality
  - Emotional
    - Happiness Mood
    - Depression/ Anxiety
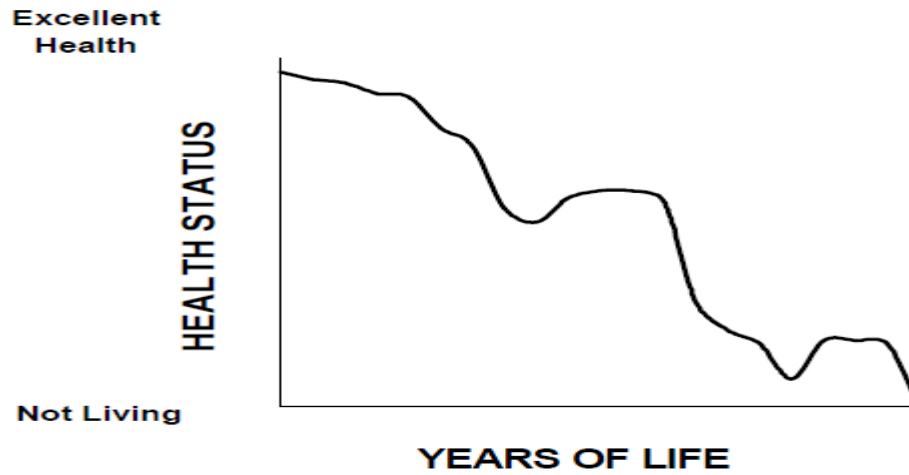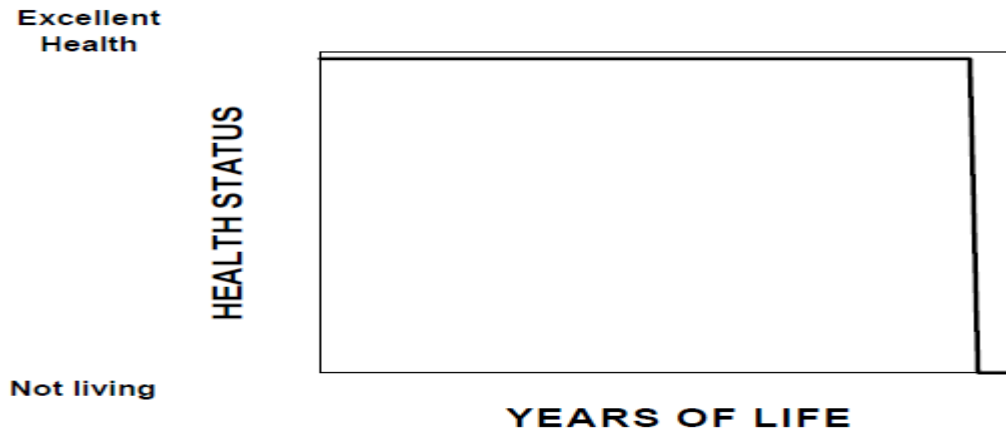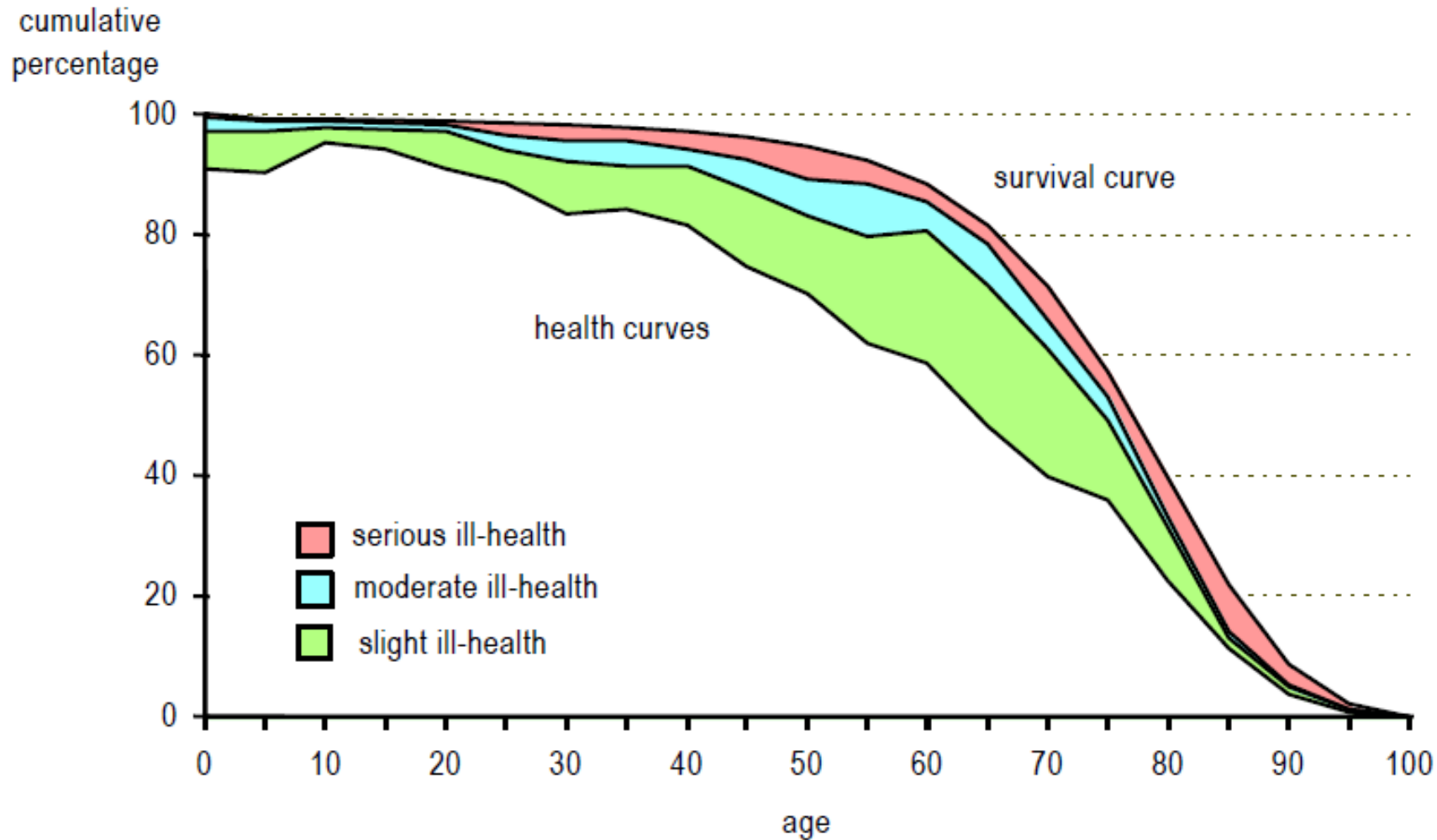    - Self Image
  - Sensory
    - Vision
    - Hearing

# Self-rated health

**How do you rate your health in the last 12 months?**
- Very good
- Good
- Average
- Bad
- Very bad

# Life paths

Excellent Health

HEALTH STATUS

Not living

YEARS OF LIFE

Excellent Health

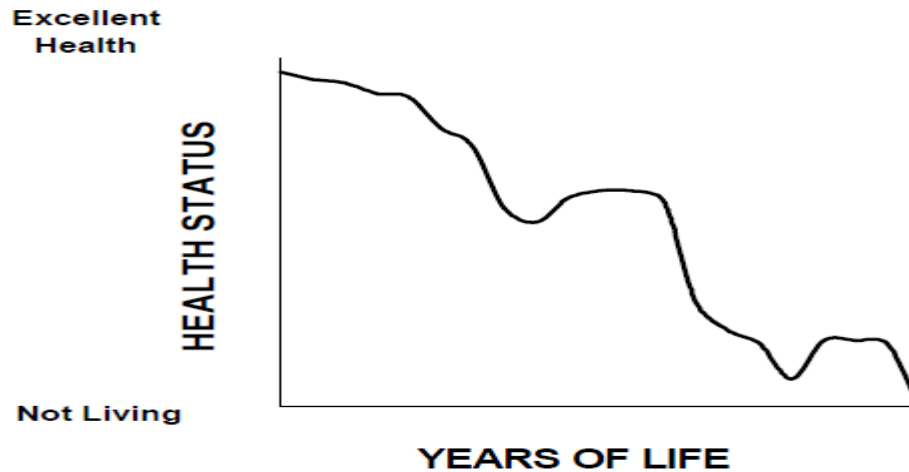HEALTH STATUS

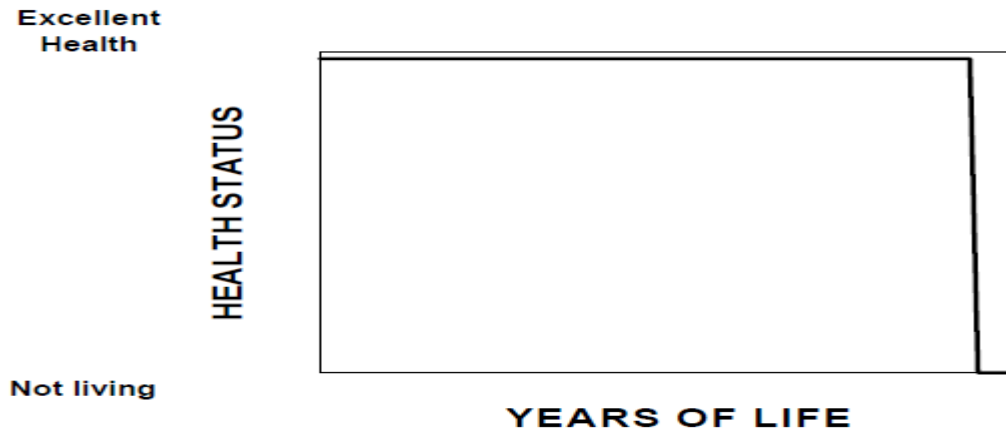Not Living

YEARS OF LIFE

# Survival and health curves

# 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

- = the average number of years that a newborn can expect to live in "full health"—in other words, not hampered by disabling illnesses or injuries.

- Summarises mortality and non-fatal 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 decreases

# Morbidity compression (rectangularisation )



Excellent Health — HEALTH STATUS — Not living

YEARS OF LIFE



Excellent Health — HEALTH STATUS — Not Living

YEARS OF LIFE

# 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
- http://www.healthdata.org/gbd

# 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
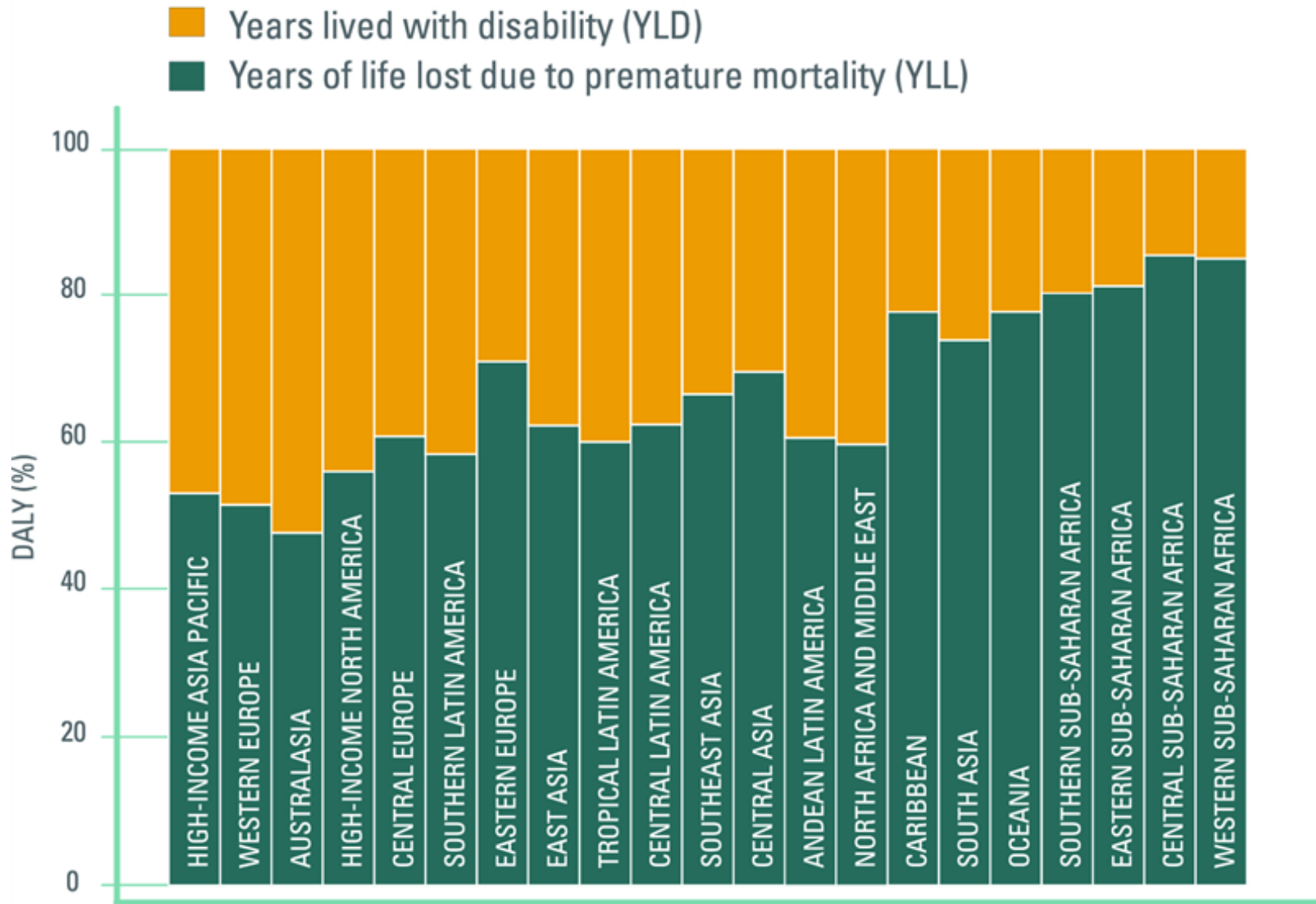  - 67 risk factors

# The disability-adjusted life years (DALY)

- A summary measure which 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 lost year of 'healthy' life.

- 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
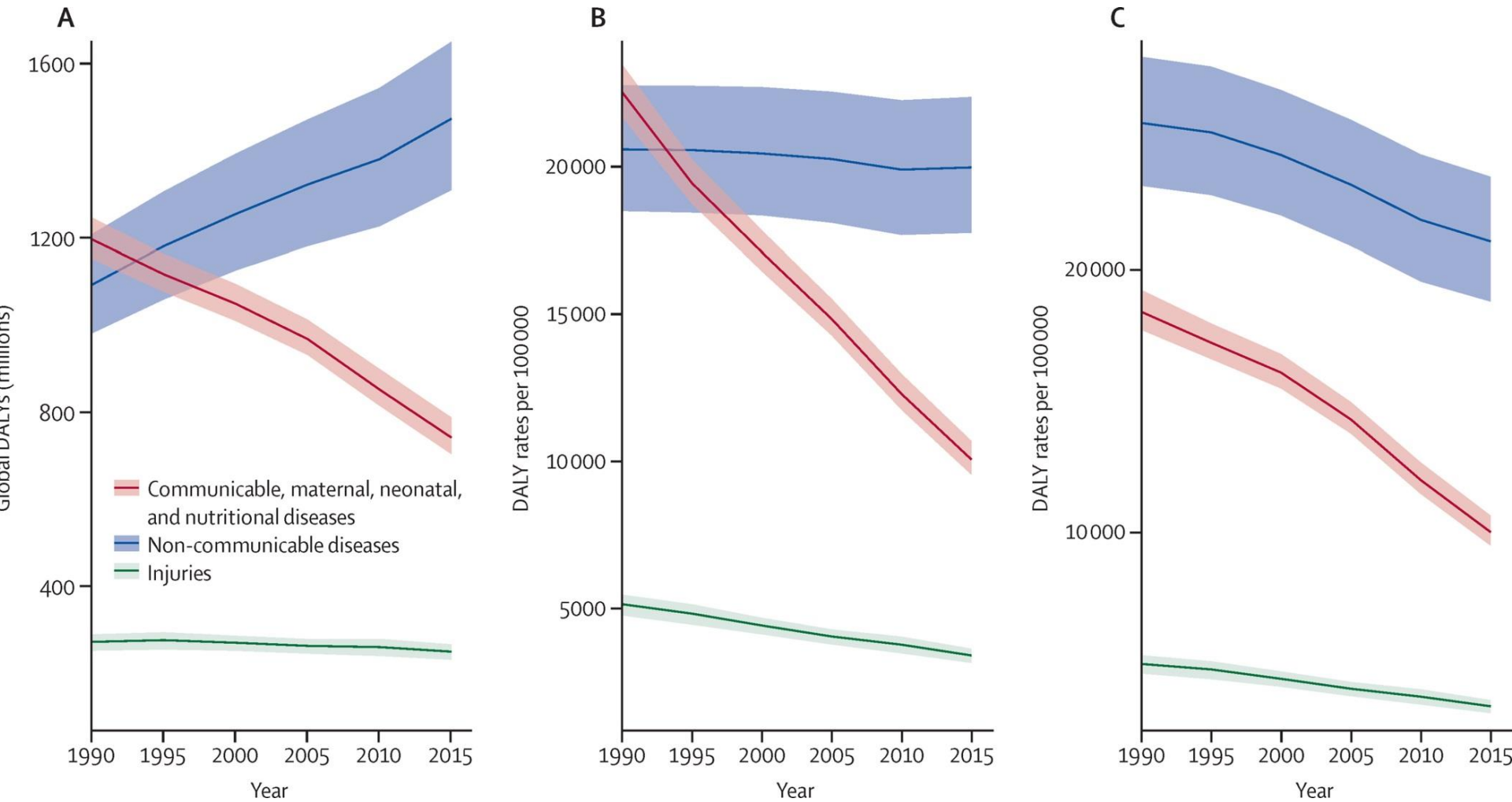
# Examples of mean disability weights (2004)

- 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

# YLL and YLD composition of total DALYs by region, 2010



Legend:
- Years lived with disability (YLD)
- Years of life lost due to premature mortality (YLL)

Y-axis: DALY (%) — 0, 20, 40, 60, 80, 100

Regions (left to right):
HIGH-INCOME ASIA PACIFIC, WESTERN EUROPE, AUSTRALASIA, HIGH-INCOME NORTH AMERICA, CENTRAL EUROPE, SOUTHERN LATIN AMERICA, EASTERN EUROPE, EAST ASIA, TROPICAL LATIN AMERICA, CENTRAL LATIN AMERICA, SOUTHEAST ASIA, CENTRAL ASIA, ANDEAN LATIN AMERICA, NORTH AFRICA AND MIDDLE EAST, CARIBBEAN, SOUTH ASIA, OCEANIA, SOUTHERN SUB-SAHARAN AFRICA, EASTERN SUB-SAHARAN AFRICA, CENTRAL SUB-SAHARAN AFRICA, WESTERN SUB-SAHARAN AFRICA

2010

# Trends in DALYs from 1990 to 2015 by cause



**(A)** – Global DALYs;  **(B)** – Crude DALY rates;  **(C)** – Age-standardised DALY rates

# 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 proportion of all-cause DALYs attributable to risk factor clusters and their overlaps by age for both sexes, 2013
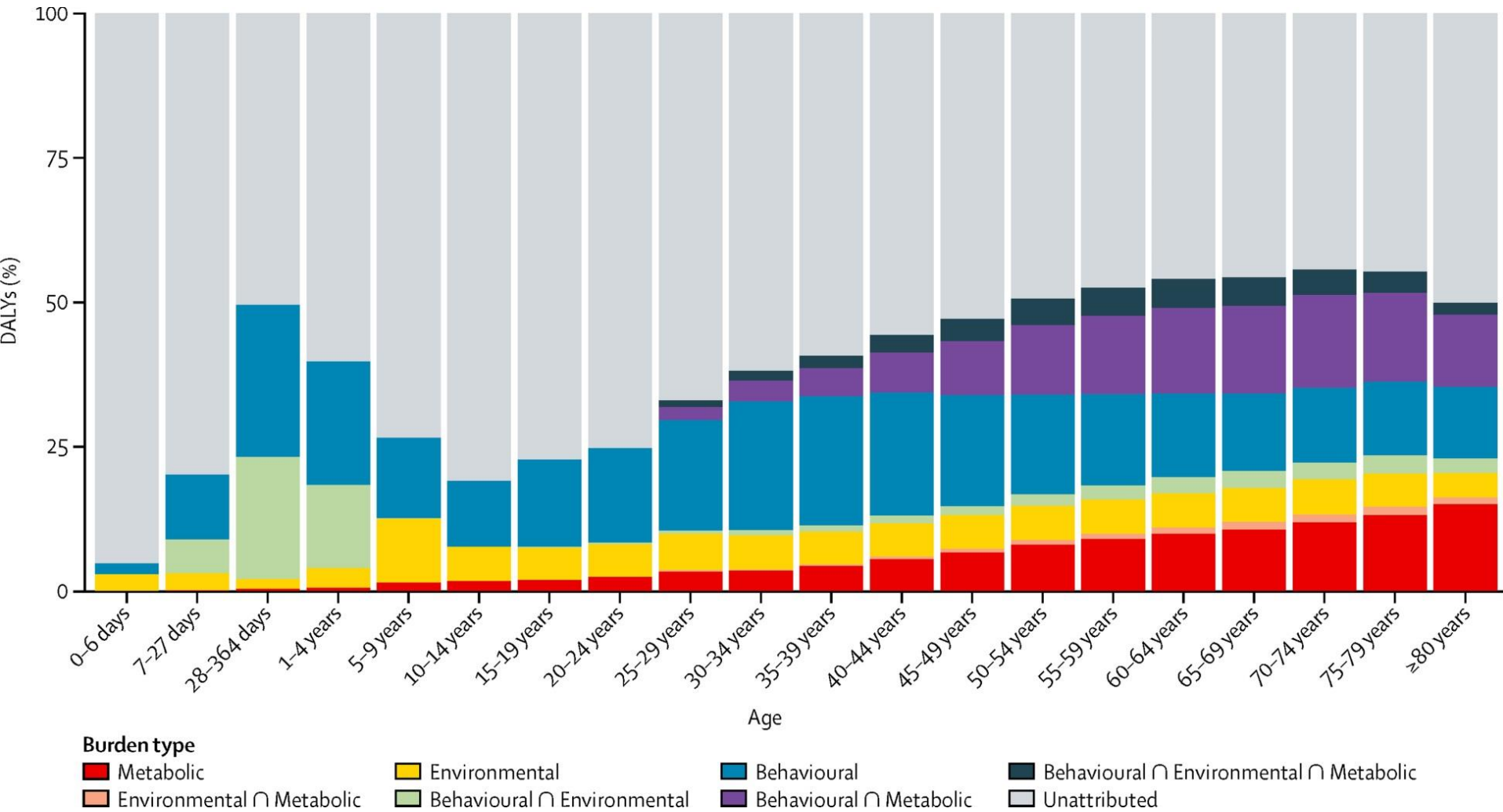
# Summary

- 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