INTRODUCTION TO DALYS: HISTORICAL AND TECHNICAL BASIS

10/09/2021 • General concepts of burden of disease

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Burden of disease

Which disease is most important?

low back pain

ischemic heart disease

common cold

Burden of disease

How to define disease "impact" or "importance"?

Disease have an impact on multiple aspects

- Burden of disease = quantification of any of these aspects
- This requires specific metrics!

Burden of disease

Which disease is most important?

low back pain　　　*ischemic heart disease*　　　*common cold*

Number of cases, **number** of deaths

⬄ **Severity** of case: duration, reduction quality of life

⬄ **Severity** of death: residual life expectancy

➔ **Summary Measures of Population Health**

Summary measures of population health

	Health Experience	Health Loss
Mortality	Life Expectancy	Potential Years of Life Lost (Years of Potential Life Lost) Standard Expected Years of Life Lost
Morbidity	Quality-Adjusted Life Year	Years Lived with Disability
Morbidity + Mortality	Active Life Expectancy Disability-Free Life Expectancy Healthy Life Years Quality-Adjusted Life Expectancy Disability-Adjusted Life Expectancy	**Disability-Adjusted Life Year**

All use "time" as a common metric!

Economic impact

	Direct	Indirect
Healthcare	Hospitalization, medication, diagnoses..	(future healthcare costs)
Non-healthcare	"Patient costs" Out-of-pocket payments, transportation..	"Productivity losses" Absenteeism, presenteism, death..

Burden of disease

Conclusion

- Diseases have a multiple impact
    - Health
    - Psychosocial well-being
    - Economy

- "Burden of Disease" is the comparative quantification of one or more of these aspects
    - BoD estimates are used by decision makers to evaluate public health, monitor public health, prioritize diseases (e.g., prevention, control, funding, ..)
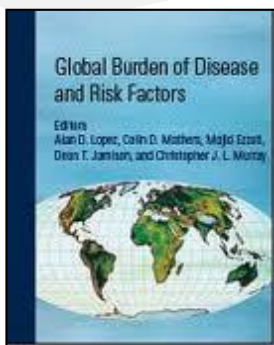
What can we learn from burden of disease studies?

Introduction to DALYs: historical and technical basis

Global Burden of Disease (GBD)

- Since the 1990s, different projects have been initiated to evaluate the global burden of disease

- Rationale: available information on the health of populations often fragmented and inconsistent

- → Need for framework to integrate, analyze and disseminate this information in a consistent way
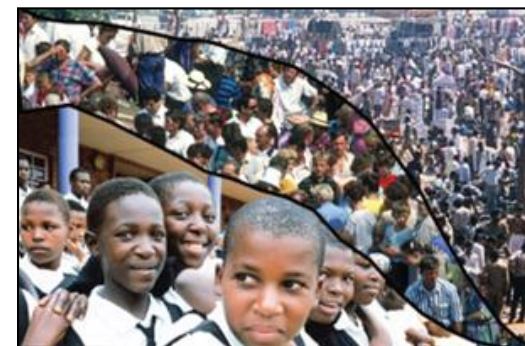
Global Burden of Disease (GBD)
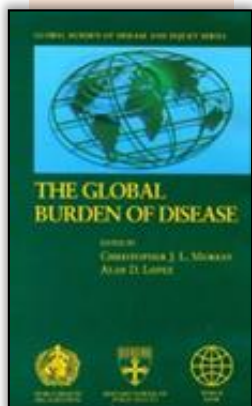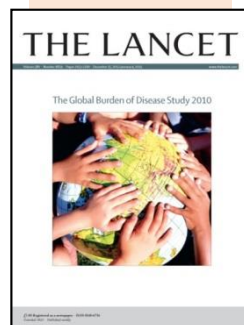

GBD2001

GBD1990

World Health Organization

IHME

GBD2004

WHO Global Health Estimates
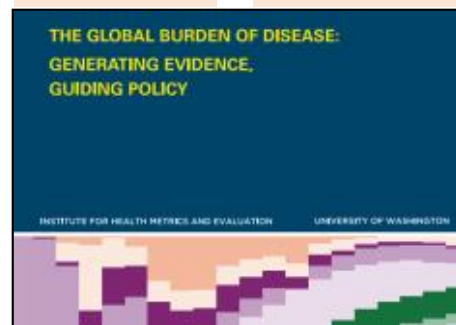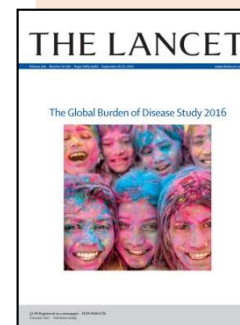
| 1996 | 2006 | 2007 | 2008 | 2012 | 2015 | 2016 | 2017 | 2018 | 2020 |

GBD2010

GBD2013

GBD2015

GBD2016

GBD2017

GBD2019

THE LANCET — The Global Burden of Disease Study 2010

THE GLOBAL BURDEN OF DISEASE: GENERATING EVIDENCE, GUIDING POLICY — INSTITUTE FOR HEALTH METRICS AND EVALUATION — UNIVERSITY OF WASHINGTON

THE LANCET — The Global Burden of Disease Study 2016

THE LANCET — The Global Burden of Disease Study 2017
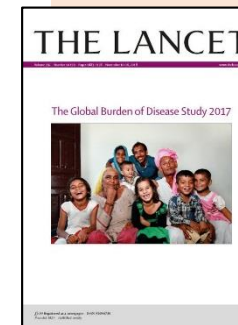
THE LANCET — The Global Burden of Disease Study 2019
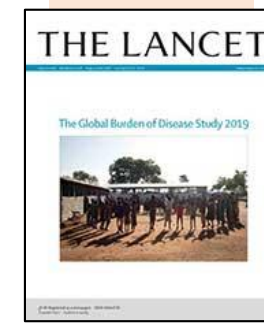
IHME/GBD

Explore the estimates of the IHME Global Burden of Disease study online via:

https://vizhub.healthdata.org/gbd-compare/

Epidemiological and demographic transition

Total DALYs

Global DALYs (millions)

- Communicable, maternal, neonatal, and nutritional diseases
- Non-communicable diseases
- Injuries

Crude DALY rates

DALY rates per 100000

Age-standardized DALY rates

DALY rates per 100000

Population growth

Population aging
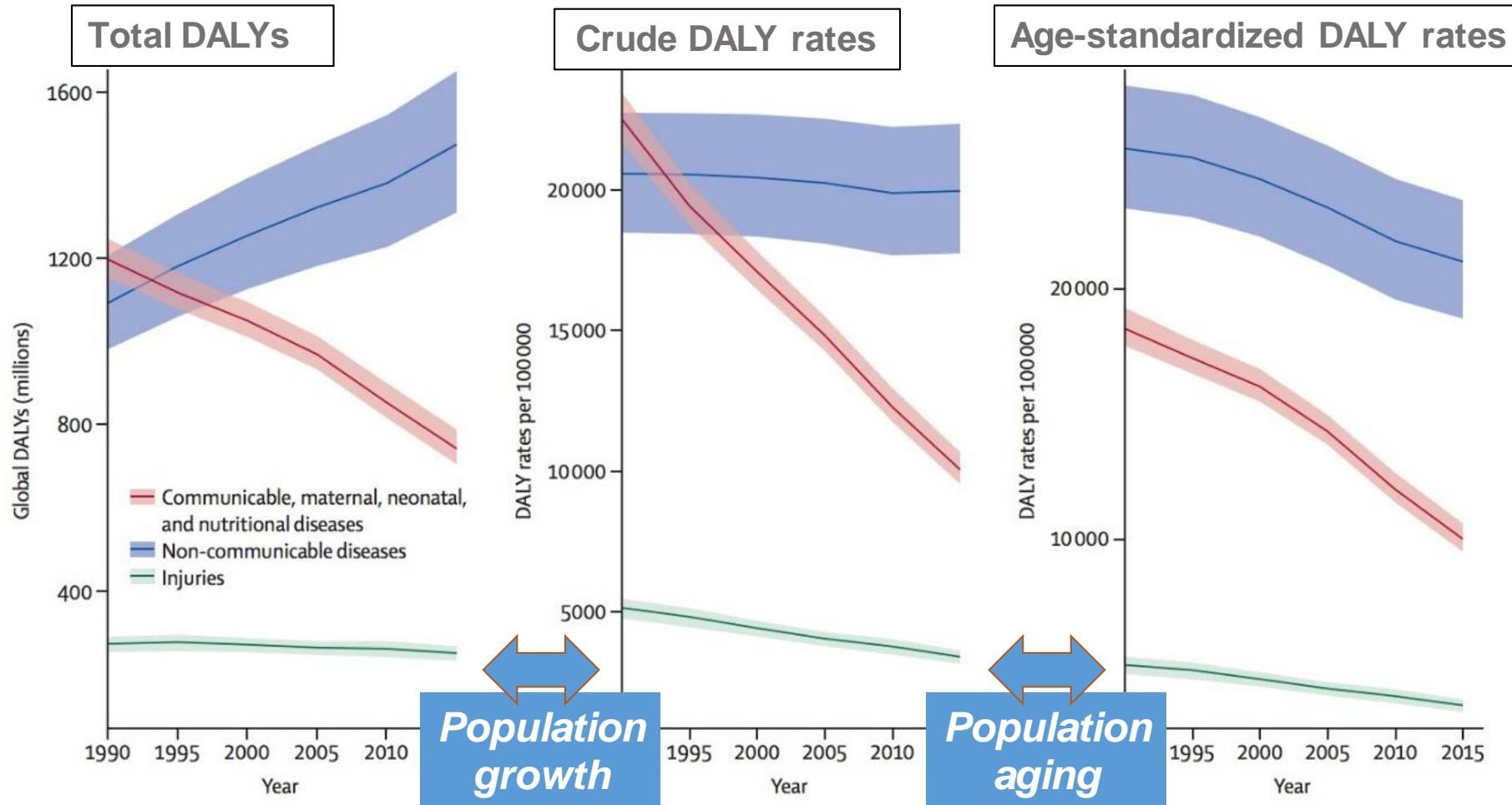
Global
Both sexes, All ages, DALYs per 100,000

1990 rank

1 Neonatal disorders
2 Lower respiratory infect
3 Diarrheal diseases
4 Ischemic heart disease
5 Stroke
6 Congenital defects
7 Tuberculosis
8 Road injuries
9 Measles
10 Malaria
11 COPD
12 Protein-energy malnutrition
13 Low back pain
14 Self-harm
15 Cirrhosis
16 Meningitis
17 Drowning
18 Headache disorders
19 Depressive disorders
20 Diabetes
21 Lung cancer
22 Falls
23 Dietary iron deficiency
24 Interpersonal violence
25 Whooping cough
26 Asthma
27 Age-related hearing loss
29 Chronic kidney disease
30 HIV/AIDS
32 Gynecological diseases
34 Anxiety disorders
35 Other musculoskeletal
56 Alzheimer's disease

2019 rank

1 Neonatal disorders
2 Ischemic heart disease
3 Stroke
4 Lower respiratory infect
5 Diarrheal diseases
6 COPD
7 Road injuries
8 Diabetes
9 Low back pain
10 Congenital defects
11 HIV/AIDS
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24 Anxiety disorders
25 Dietary iron deficiency
26 Interpersonal violence
27 Alzheimer's disease
34 Asthma
40 Meningitis
41 Protein-energy malnutrition
46 Drowning
55 Whooping cough
71 Measles

Legend:
- Communicable, maternal, neonatal, and nutritional diseases
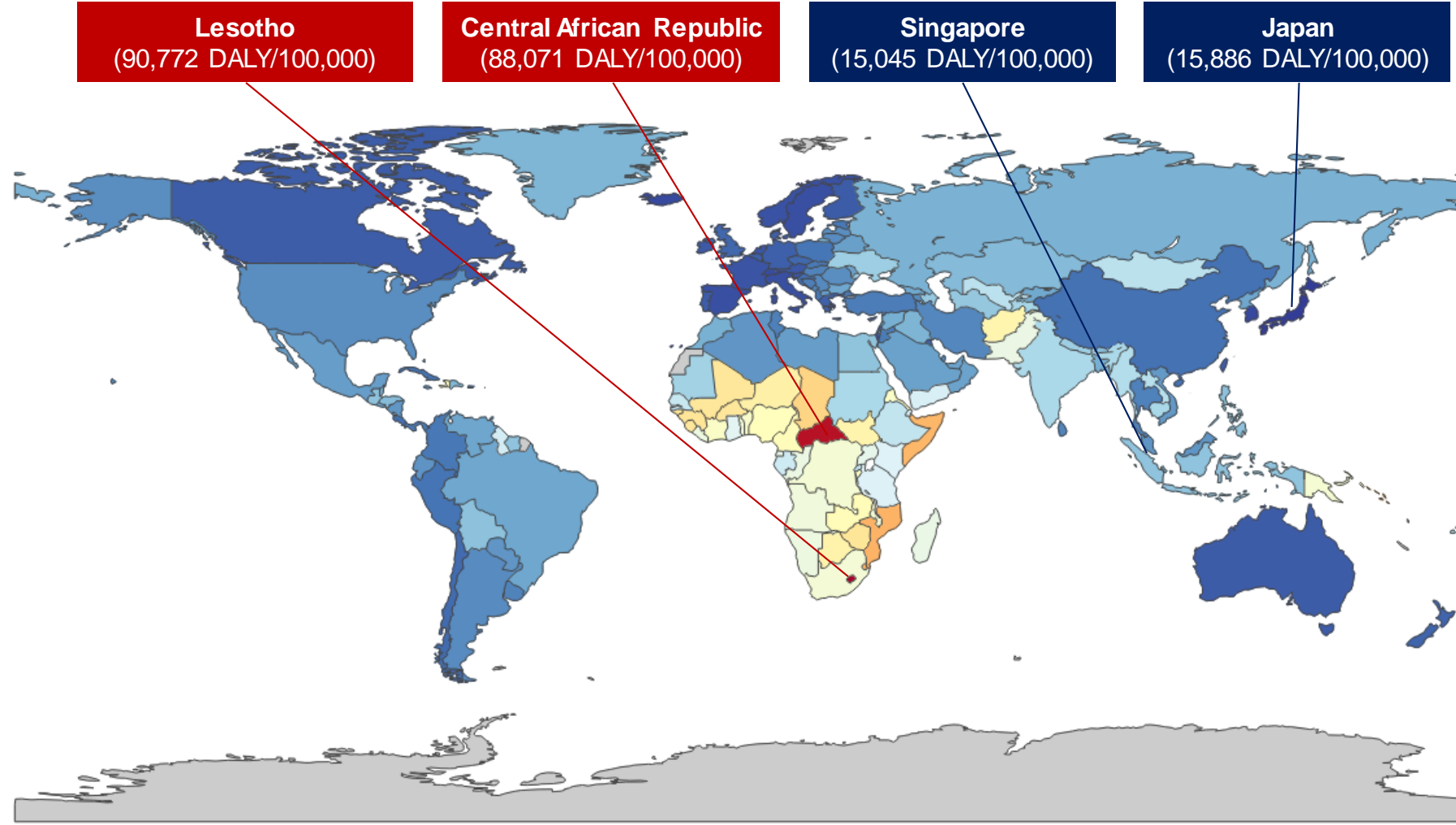- Non-communicable diseases
- Injuries

Global Burden of Disease

Which countries have the highest and lowest levels of health?

All causes
Both sexes, Age-standardized, 2019, DALYs per 100,000
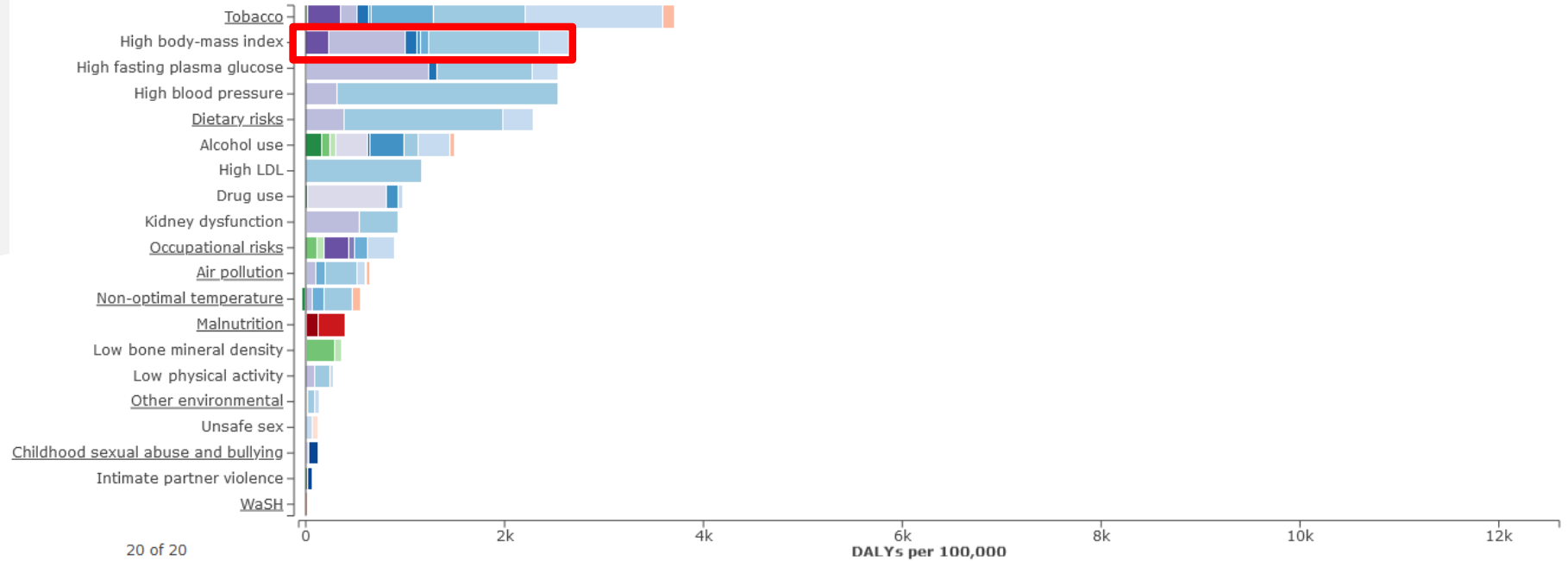
Lesotho
(90,772 DALY/100,000)

Central African Republic
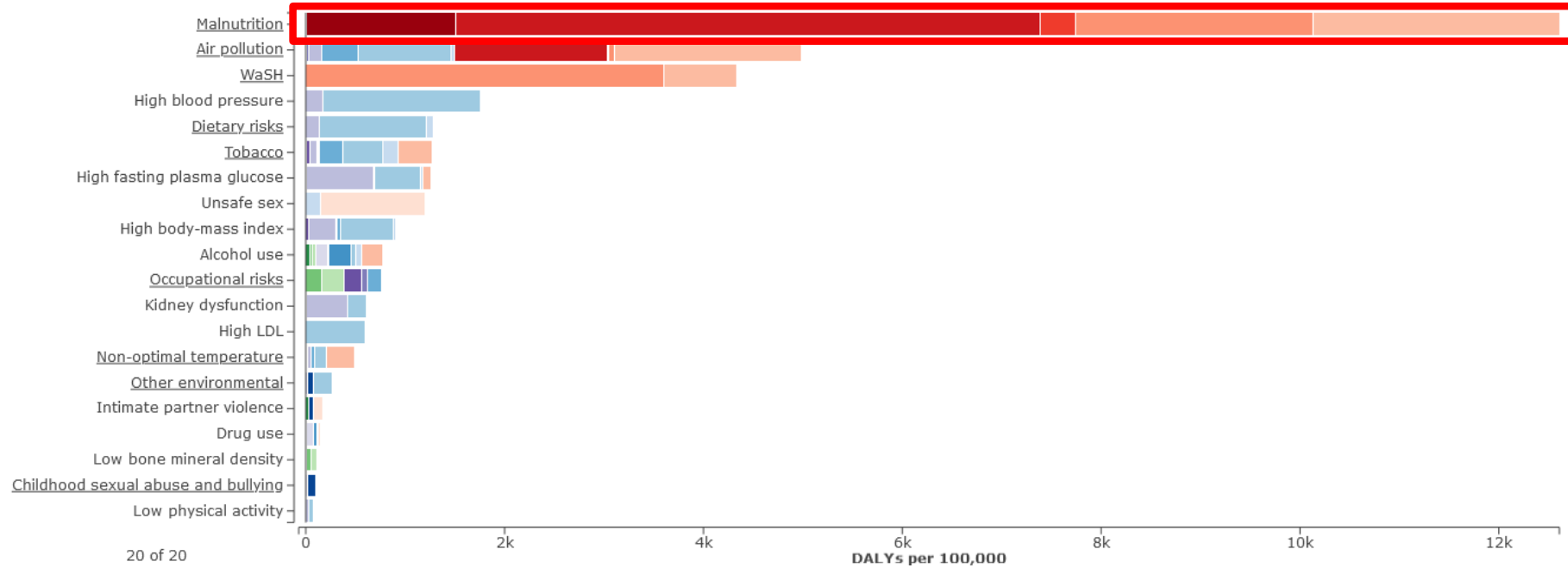(88,071 DALY/100,000)

Singapore
(15,045 DALY/100,000)

Japan
(15,886 DALY/100,000)

15k   20k   30k   40k   50k   60k   70k   80k   9 91k

Set scale

Reset

High SDI, Both sexes, All ages, 2019

Risk factor
Tobacco
High body-mass index
High fasting plasma glucose
High blood pressure
Dietary risks
Alcohol use
High LDL
Drug use
Kidney dysfunction
Occupational risks
Air pollution
Non-optimal temperature
Malnutrition
Low bone mineral density
Low physical activity
Other environmental
Unsafe sex
Childhood sexual abuse and bullying
Intimate partner violence
WaSH

20 of 20

DALYs per 100,000

Low SDI, Both sexes, All ages, 2019

Risk factor
Malnutrition
Air pollution
WaSH
High blood pressure
Dietary risks
Tobacco
High fasting plasma glucose
Unsafe sex
High body-mass index
Alcohol use
Occupational risks
Kidney dysfunction
High LDL
Non-optimal temperature
Other environmental
Intimate partner violence
Drug use
Low bone mineral density
Childhood sexual abuse and bullying
Low physical activity

20 of 20

DALYs per 100,000

Epidemiological transition

Nigeria
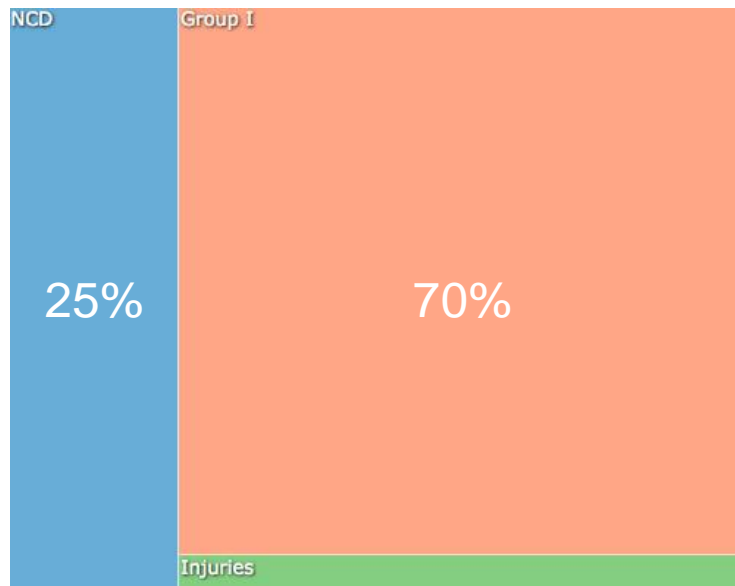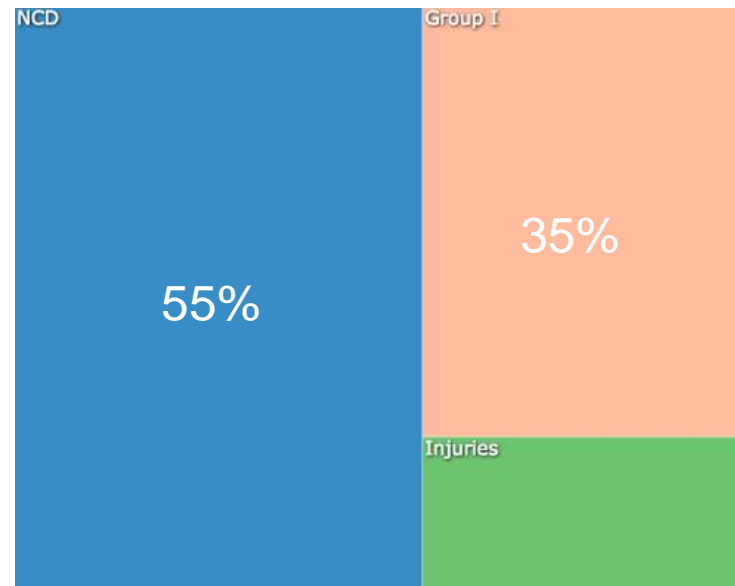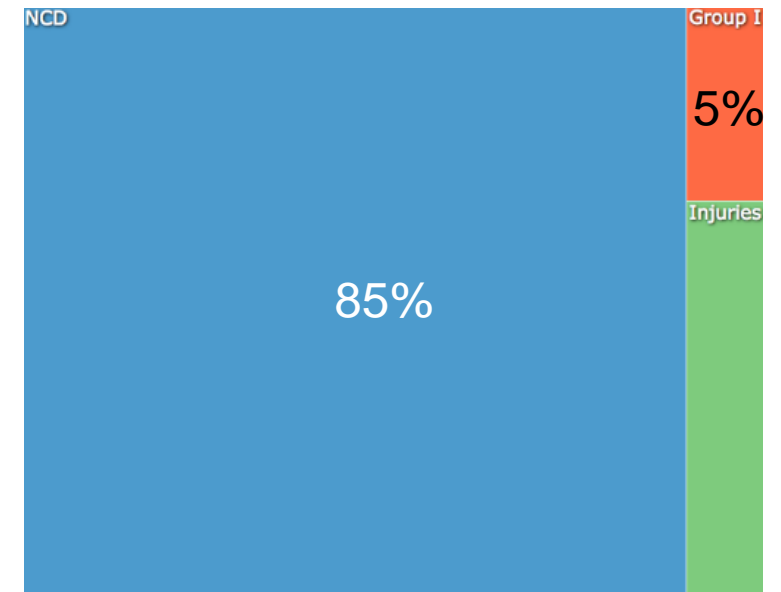
NCD	Group I	Group I
25%		5%
	70%	
	Injuries	

India

NCD	Group I	
55%	35%	
	Injuries	

Belgium

NCD	Group I
	5%
85%	Injuries
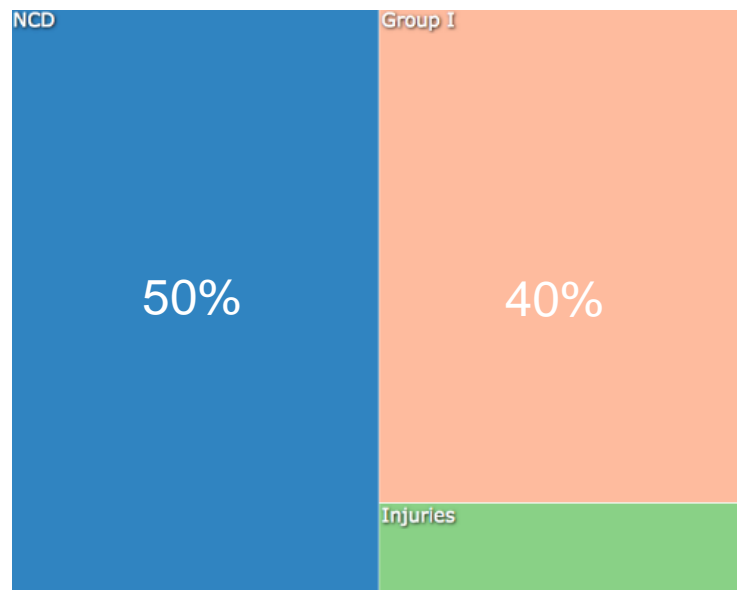
Epidemiological transition
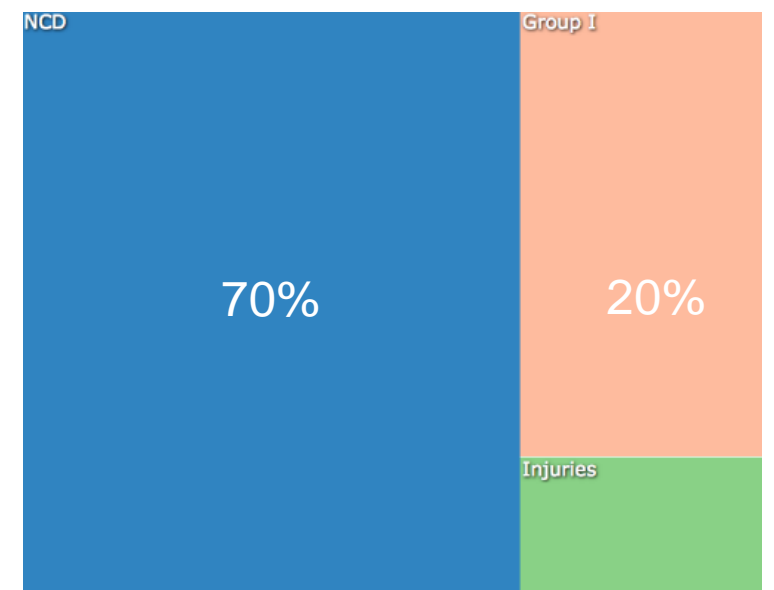
Global burden of disease (GBD)

Conclusion

- The GBD projects are comprehensive frameworks
  - Consistent and comparable descriptions of the BoD

- GBD 1990 → 2019
  - Global health has improved
  - Demographic & epidemiological transition
  - NCDs (becoming) more important than CDs
    - .. both in developed AND developing countries
  - HIV/AIDS epidemic
  - Health inequalities have not diminished!

Disability-Adjusted Life Years

- DALYs developed early 1990s, Harvard School of Public Health & WHO
- Commissioned by World Bank
- DALY philosophy:

  « Treating like health outcomes as like »
- Coherent, comparable description of disease burden across countries
- **Global Burden of Disease 1990**
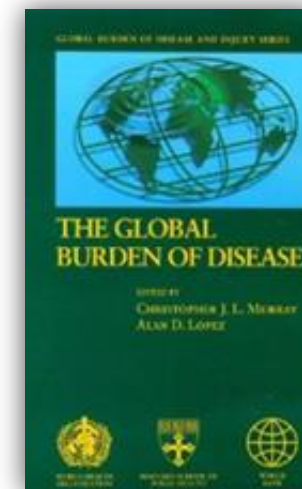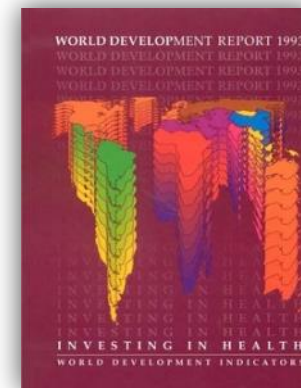
Disability-Adjusted Life Years
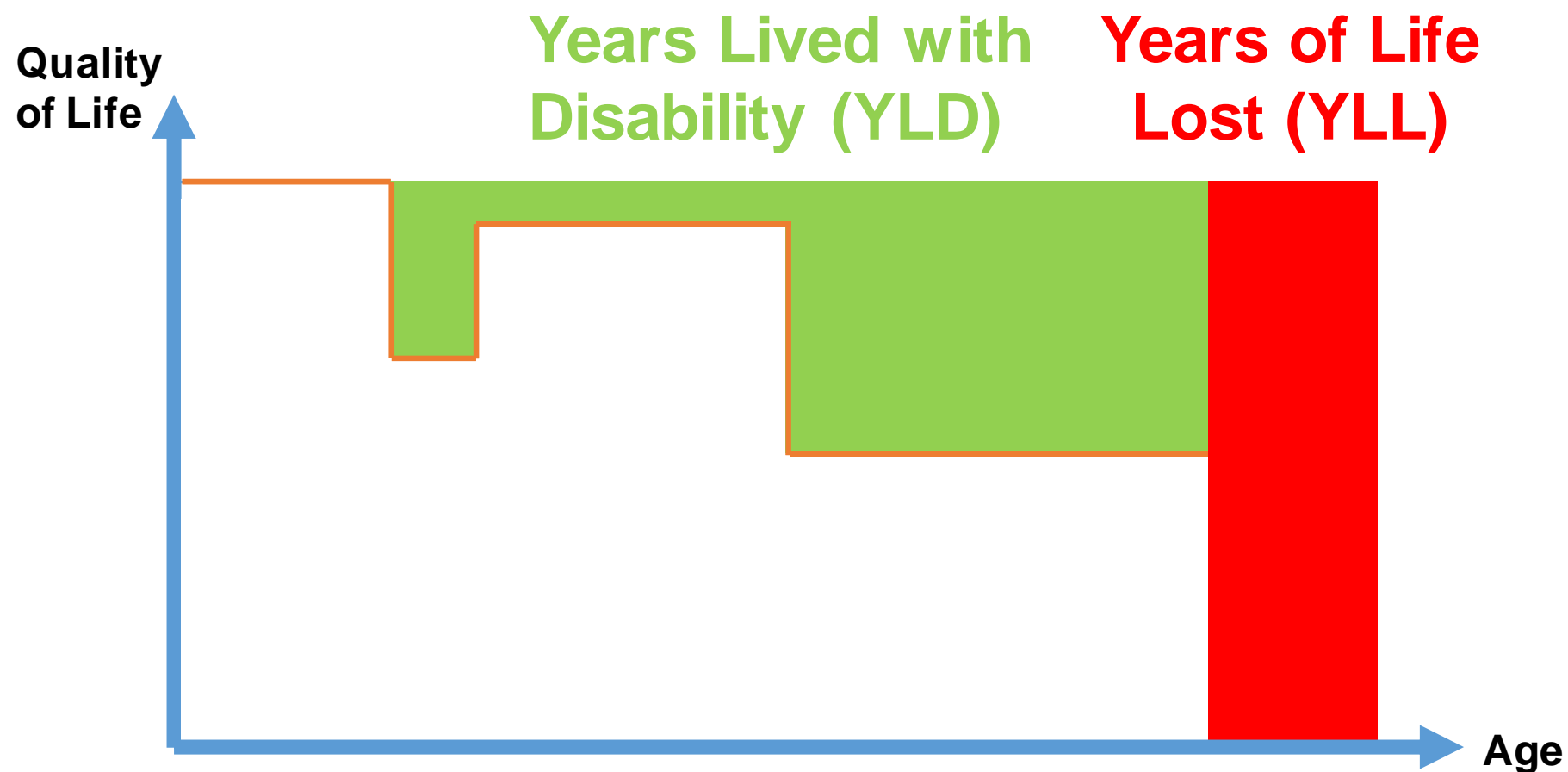
Disability-Adjusted Life Years

- **1 DALY = 1 healthy life year lost**

- Summary measure of population health
  - Morbidity + mortality
  - Disease occurrence + disease severity

- DALY = YLD + YLL
  - YLD = Years Lived with Disability
    = Number of incident cases×Duration×Disability Weight
  - YLL = Standard Expected Years of Life Lost
    = Number of deaths×Residual Life Expectancy

Disability-Adjusted Life Years
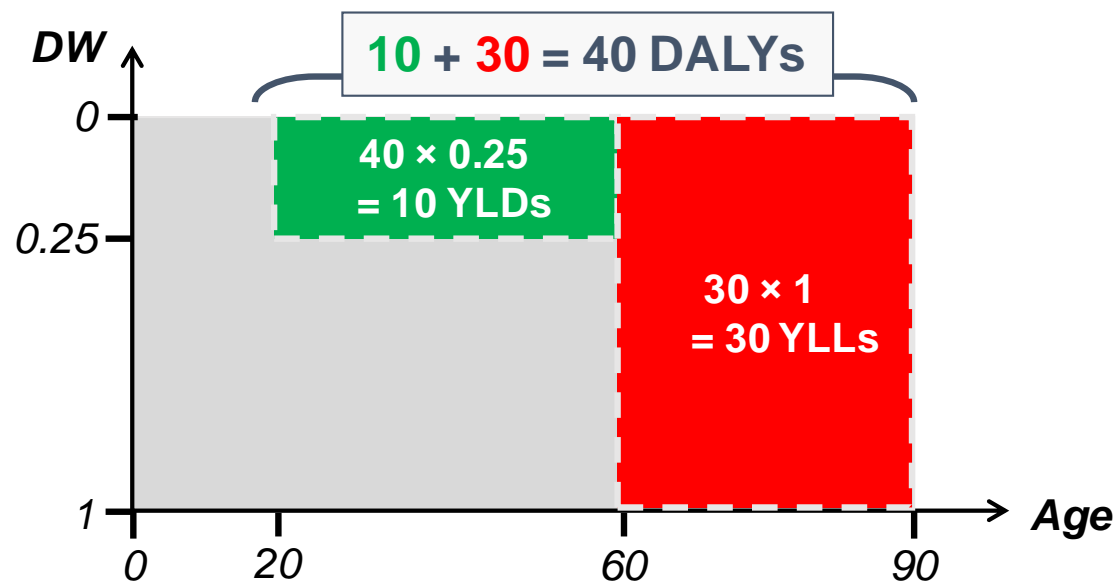
DALY = YLD + YLL

- YLD = Years Lived with Disability = N×D×DW
- YLL = Years of Life Lost = M×RLE

Disability-Adjusted Life Years

- Different perspectives possible

- **Incidence** perspective
  - YLD = N×D×DW
  - Future health losses due to current exposures
  - Often used for infectious diseases

- **Prevalence** perspective
  - YLD = P×DW
  - Current health losses due to past exposures
  - Often used for chronic diseases

Incidence vs Prevalence
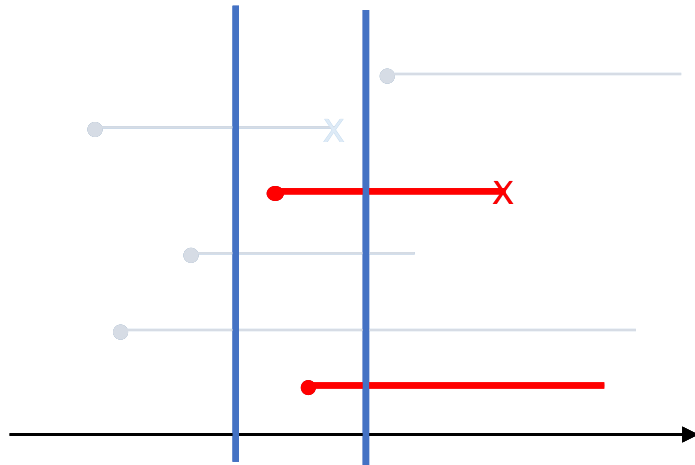
~ <u>future</u> health losses due to <u>current</u> exposures

~ attributed to age at onset

~ disease prevention and control
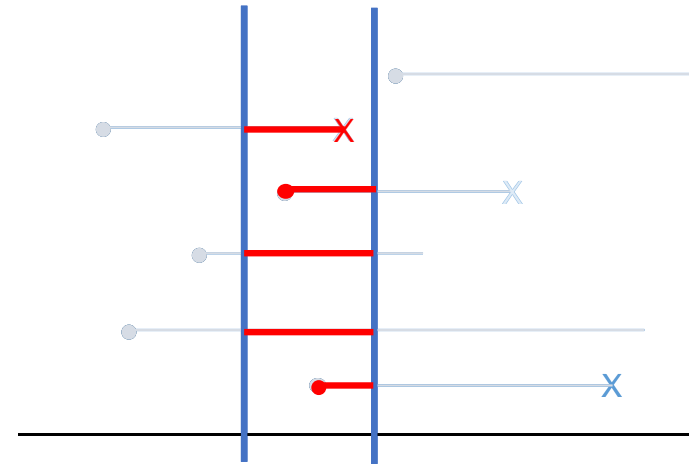
~ <u>current</u> health losses due to <u>past</u> exposures

~ attributed to age in reference year

~ healthcare burden

Disability weights

Relative severity of symptom/health state
- 0 = 0% = perfect health
- 1 = 100% = worst possible health state, death

0.005: hearing loss, minor	**0.433**: migraine	**0.756**: schizophrenia, acute stage
0.072: controlled epilepsy	**0.494**: amputation of both legs, without treatment	

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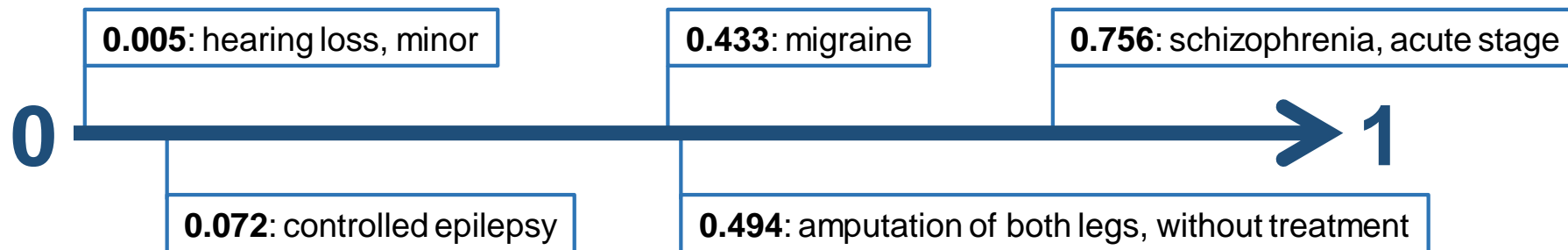
Residual life expectancy table
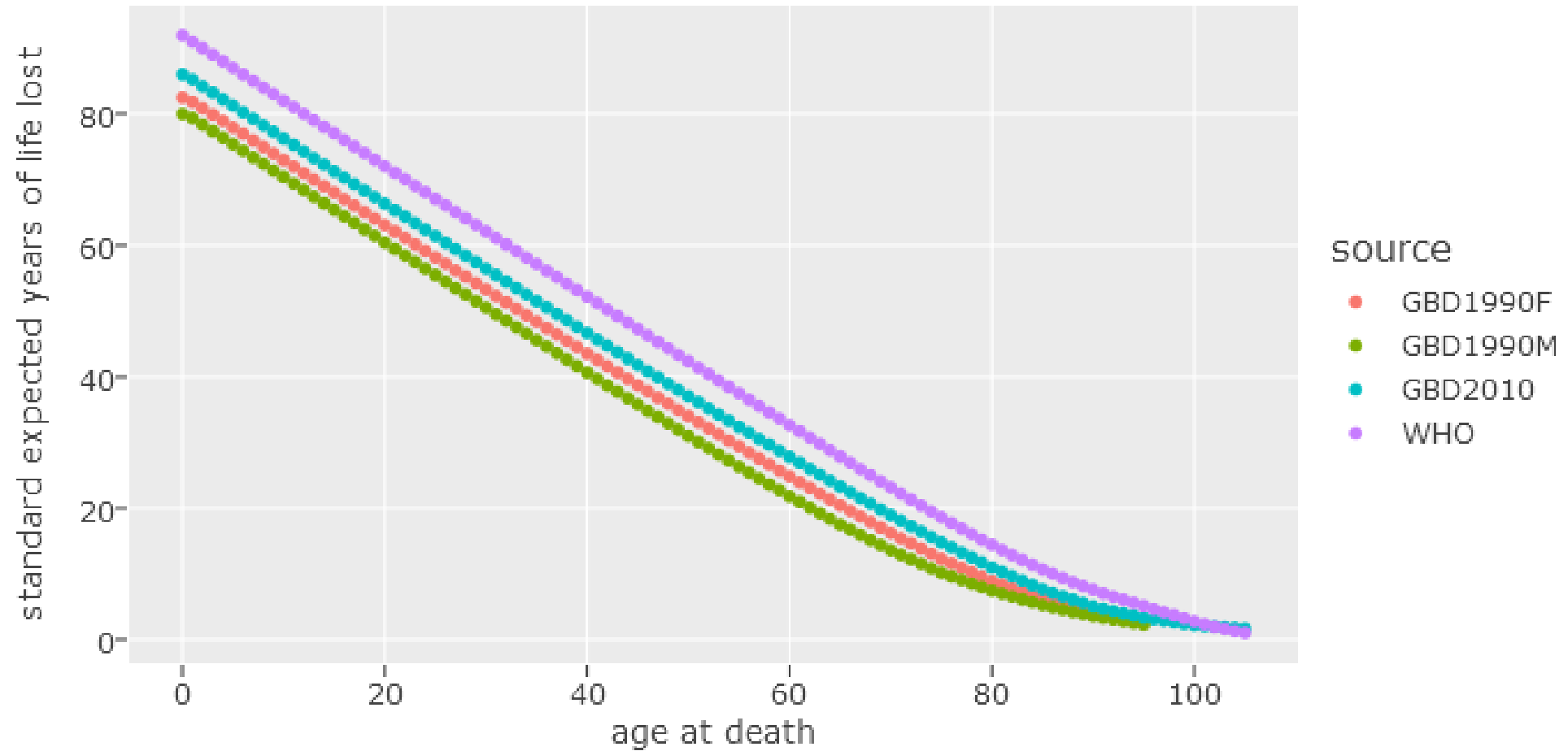
Disease models

Disease model, outcome tree

Schematic representation of "health states"
- acute, chronic stages; complications; death
- multiple severity levels

Point of interest
- Outcome-based
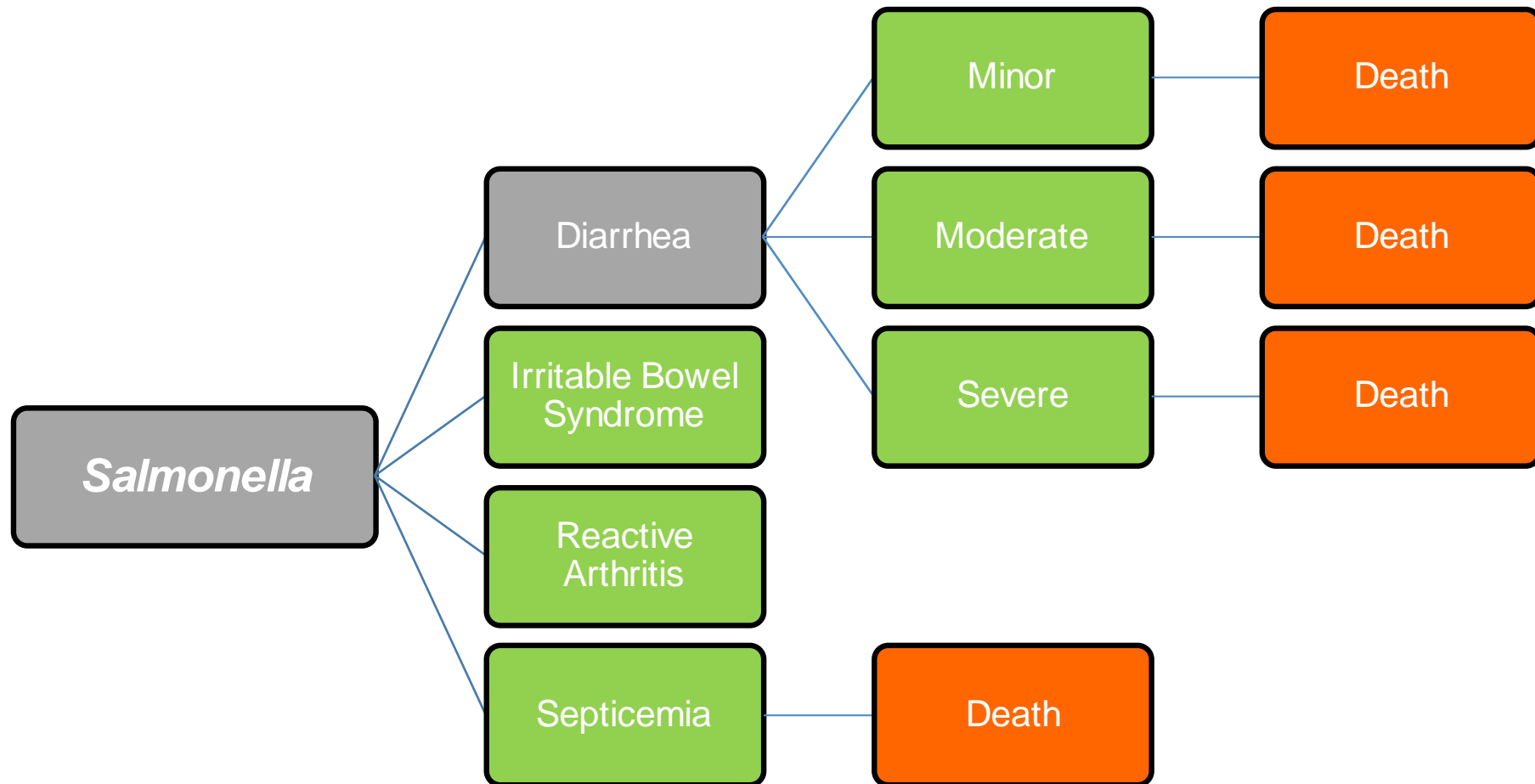- Hazard-based, pathogen-based
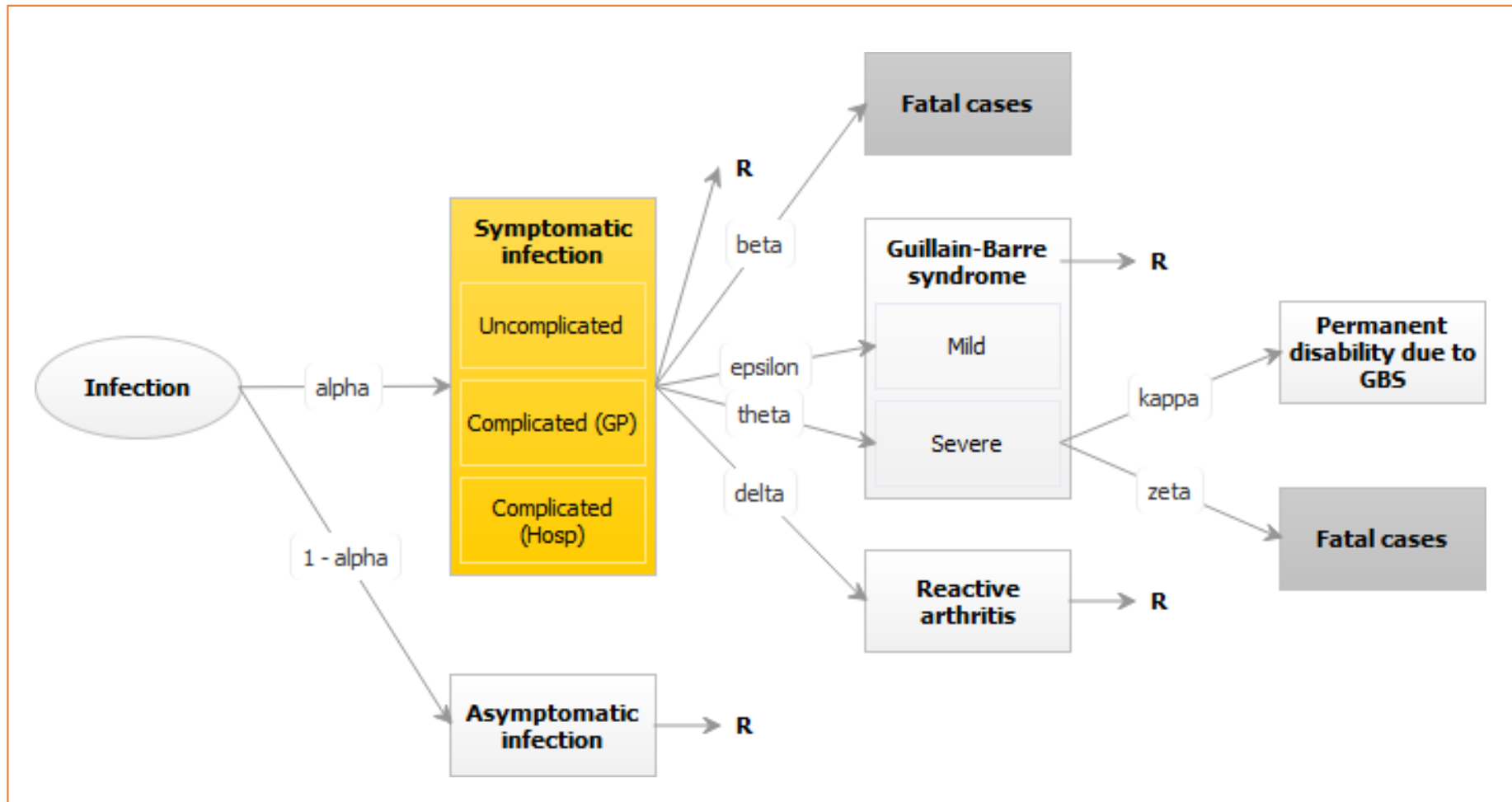- Risk factor-based
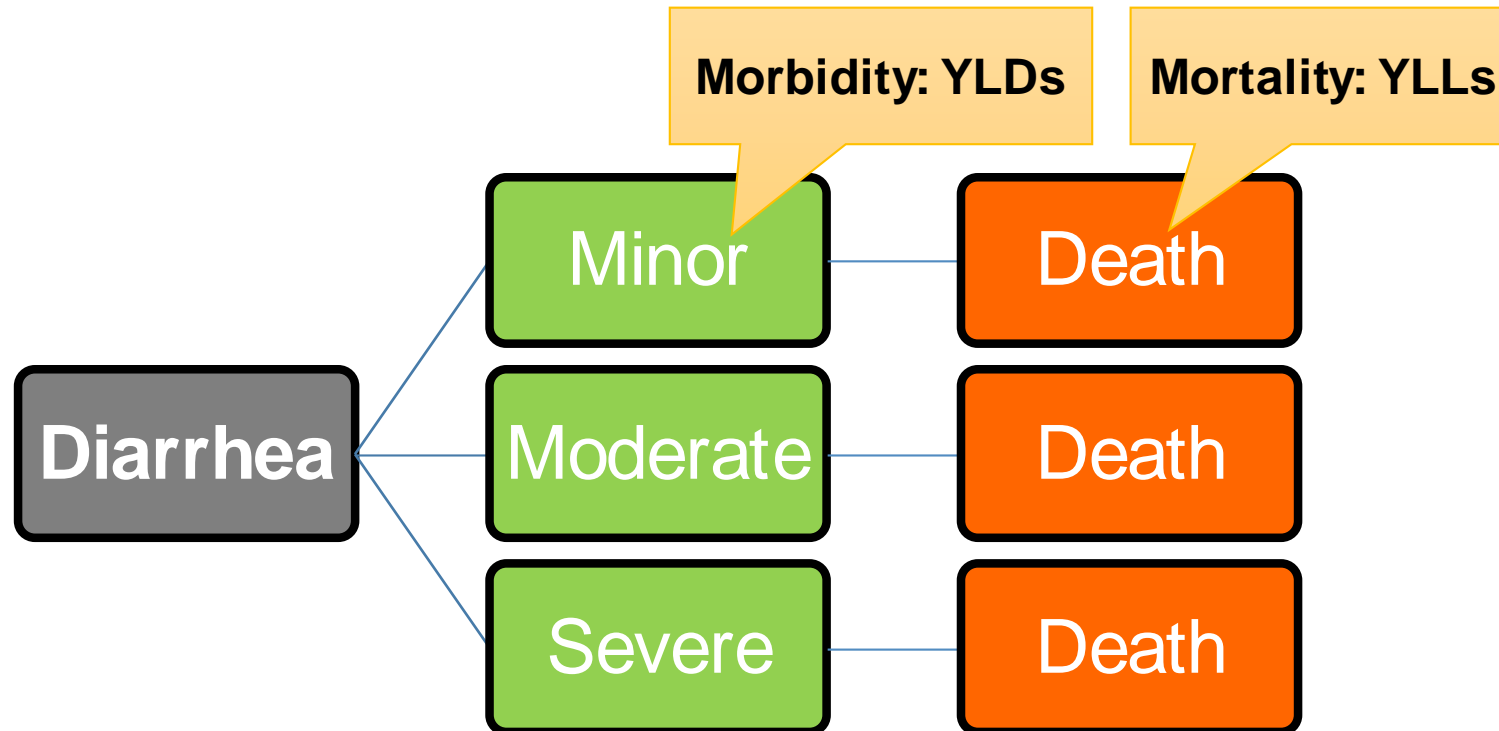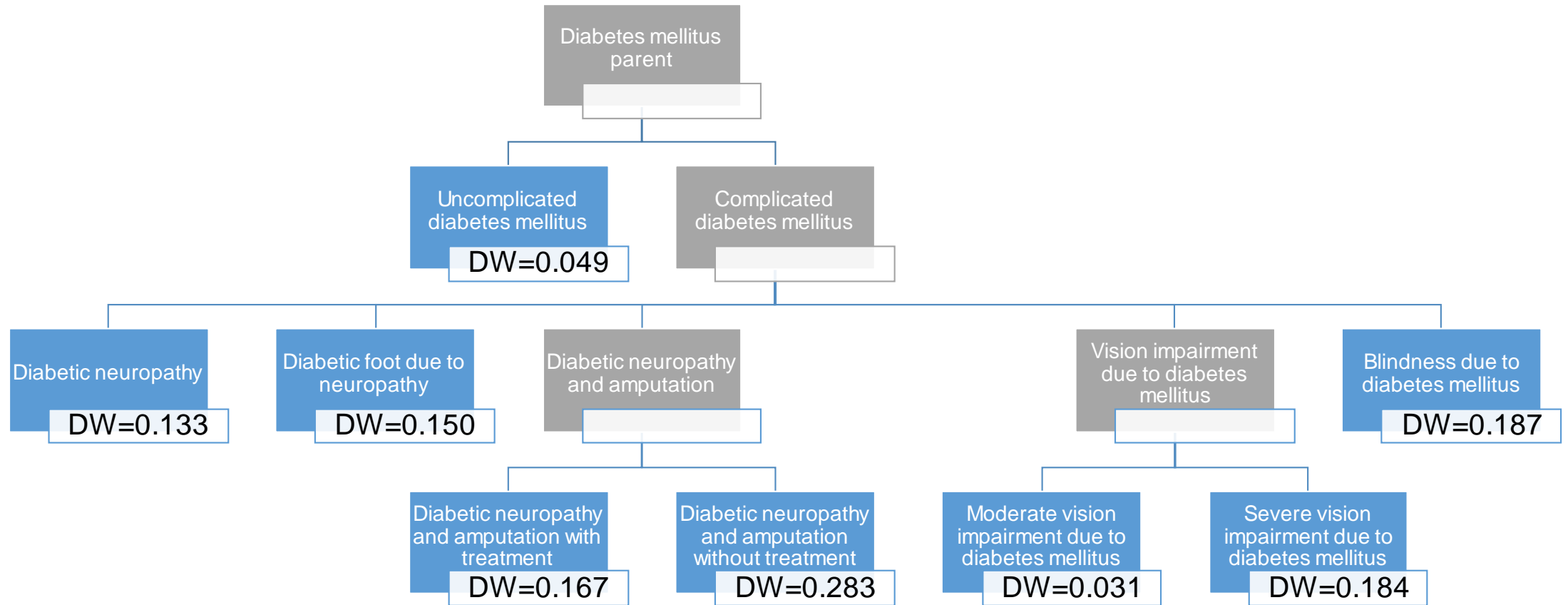
Disease models > Outcome based

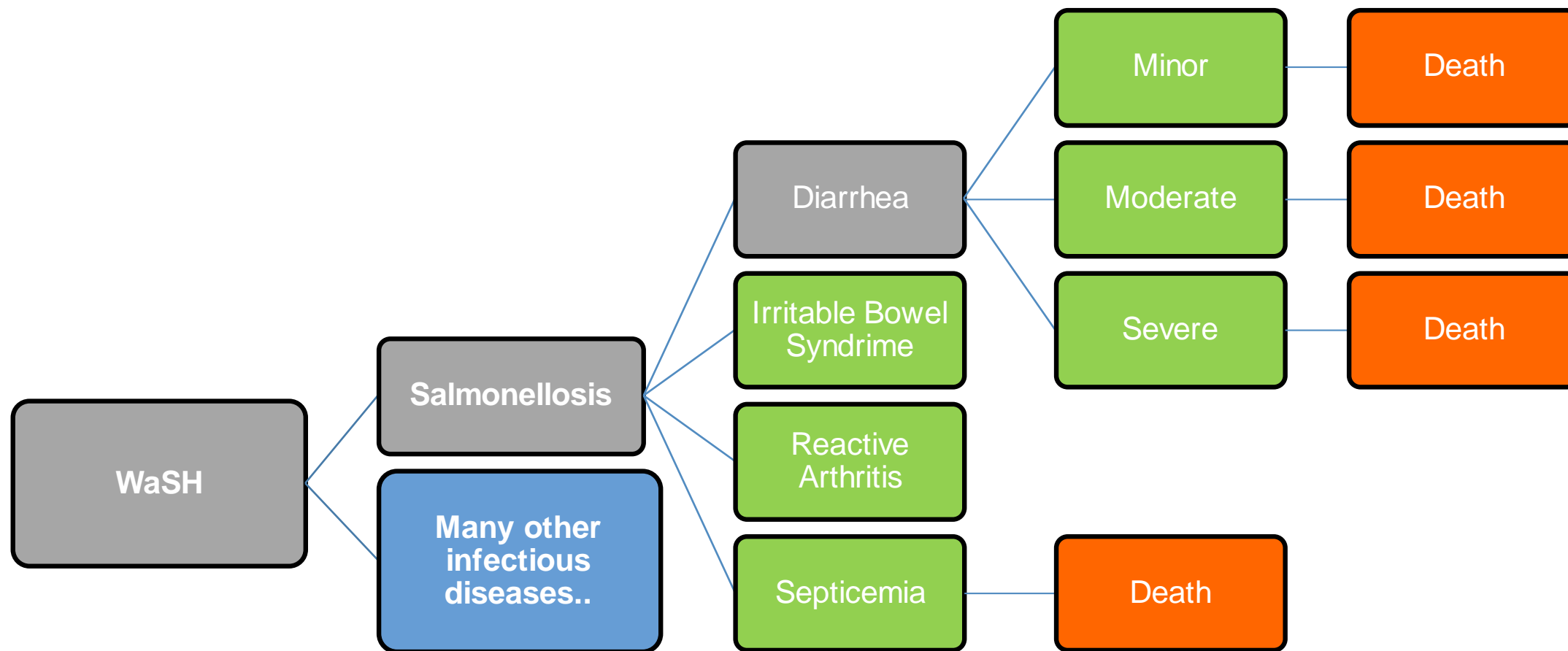# Disease models > Outcome based
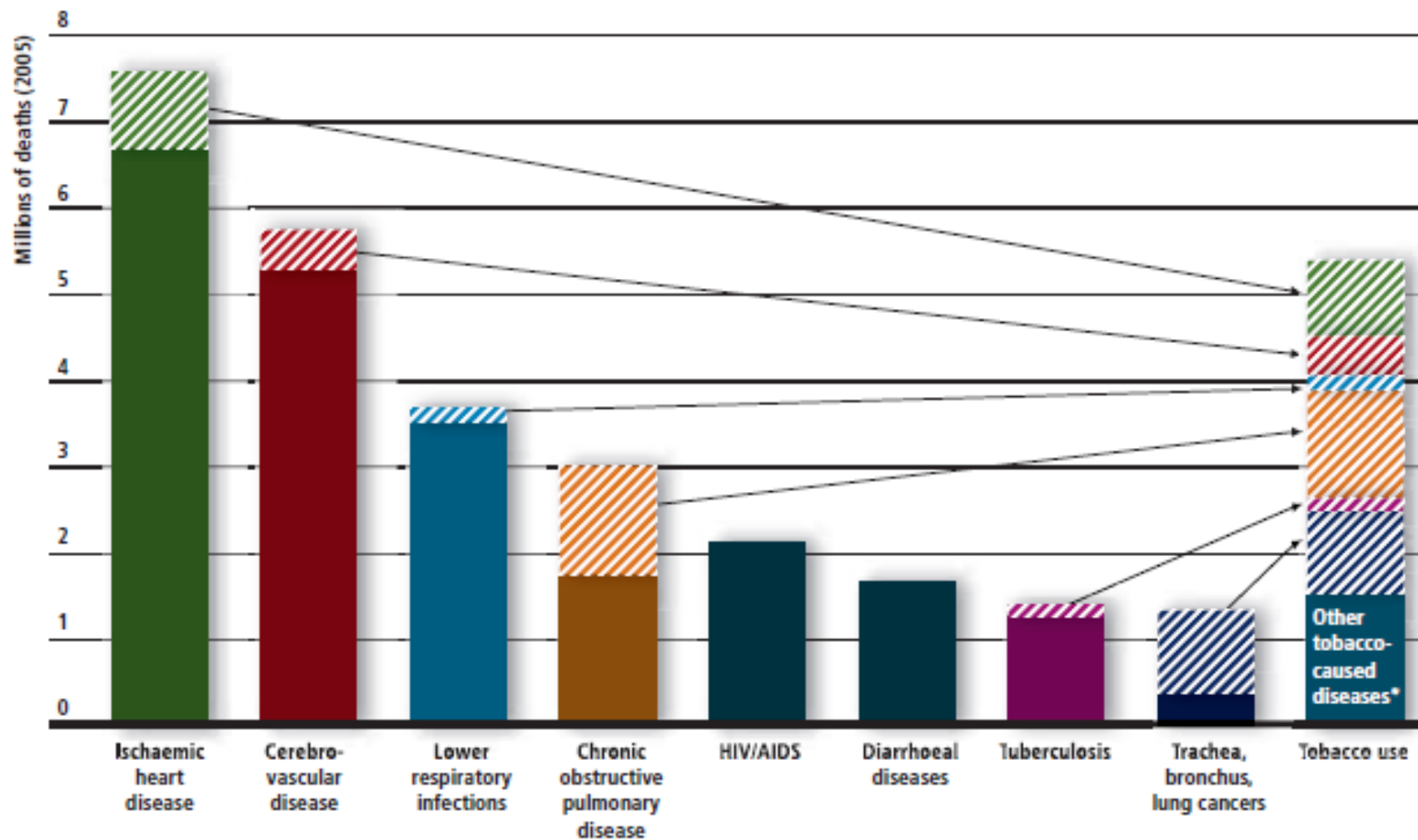
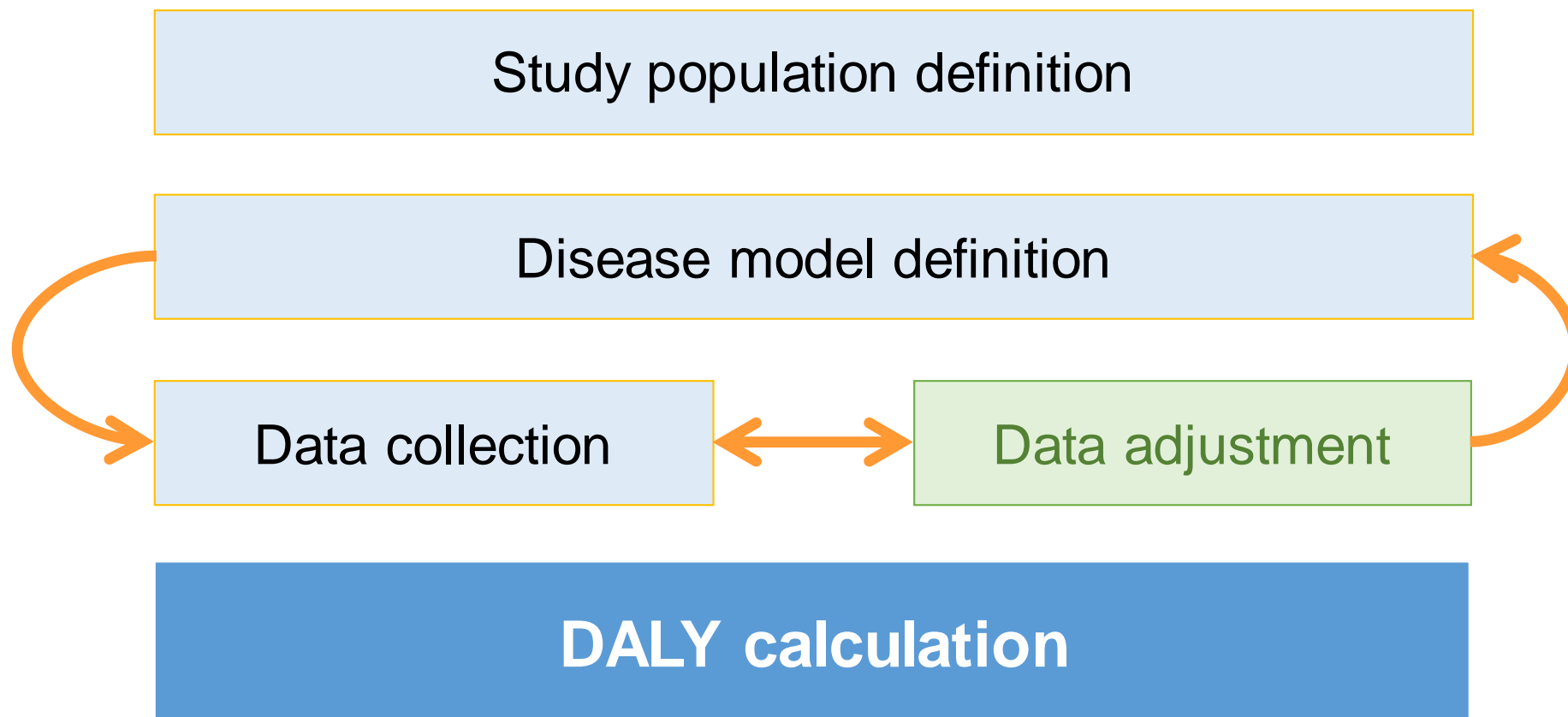# Disease models > Hazard based

Disease models > Hazard based

Disease models > Risk factor based

Disease models > Risk factor based

DALY calculation in practice

Disability-Adjusted Life Years

Conclusion

- DALYs are healthy life years lost
- DALYs are summary measures of population health
    - Morbidity + mortality
    - Occurrence + severity
- DALYs require
    - Epidemiological and clinical data
    - Disability weights, residual life expectancy
    - Disease models

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